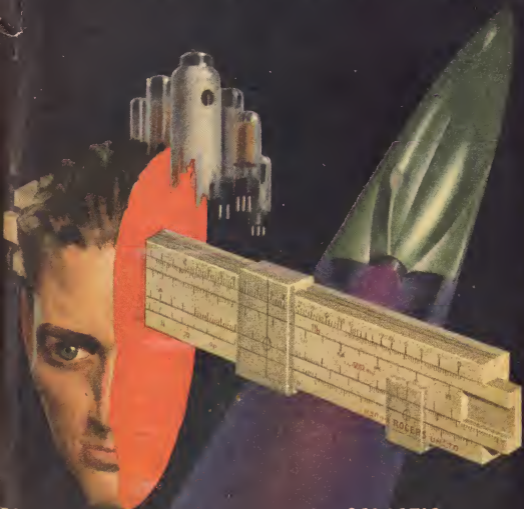


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**GALACTIC
GADGETEERS**

by Harry Stine

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CONSERVATISM

There is considerable evidence that the general mass of mankind has the firmly fixed opinion that opinions should be firmly fixed. Somehow there is a general idea that it shows weakness of intellect to change one's opinions—an unstable character, or something, if you admit that possibly you have learned something new, and have, in consequence, got a new orientation on things.

Conservatives lead an uncertain life, these days. Now it used to be, back around 1200 A.D. that a man could get an opinion when he was ten years old, and when he died of old age twenty-five or thirty years later, that opinion would be just as good as ever. (Of course, since old age came a lot earlier in the days before doctors changed some of their opinions, there was somewhat less stress on ideas.)

In those days a man could learn to plow, with pointed stick and ox, and he could plow happily in the manner of his great-great grandfather, and

be sure he was doing things right. It was a sound, solid, dependable world. A man could be born a serf, and spend his life without any uncertainties or worries; he knew his exact place in the scheme of things, and knew beyond doubting that he was going to stay right there. A nobleman, tenth class, knew his exact place, too. It was a safe, orderly existence, back in the good old days. You learned a few hundred stock answers to a few hundred stock problems, you knew all any man had to know. From there on out, you could let your mind relax, stop learning, stop thinking, and follow happily in a well laid-out pattern.

This was a far more comfortable thing than our present unreliable hodgepodge. Social customs change; beliefs change. The right way to run a farm used to be pretty stable for a half millennium at a time. Now these danged scientists come out with something new every ten years, and if the farmer doesn't want to use it,

he gets swamped by his neighbors who are growing hybrid corn on well-fertilized fields. The days when a man could spend five years as an apprentice to a trade, and know that the next two centuries would see no marked changes are gone. A man trying to be a five-year apprentice these days is apt to find the industry he's gone into wiped out in three years.

There's change and shifting, and an uncertainty of fog and shapes that loom up dissolve in smoke. There's instability of the whole pattern. A man learns a pattern of behavior—and in five years it doesn't work. The comfortable certainty that he's finished his schooling, and can now sit back mentally and vegetate the rest of his life is gone.

Seemingly, most people resent the need for continuing thought. Things shouldn't be that way; when you've learned a trade, it oughta stay learnt—not always be shiftn' the dern thing.

Technological unemployment is a polysyllabic term meaning "the employee insists on sticking to his old training pattern. He refuses to learn a new one." Occasionally, of course, the need for thinking is brought home rather firmly; buggy whip makers found that objecting to changing public interests had very little influence.

The more important form of refusal to learn new training patterns, however, is not at the worker level; it's at management level. The man who runs a machine is expected to think in terms of the operation of

that machine. The man who runs a company, however, or the man who runs a state—a nation—is supposed to think in somewhat broader terms.

It is astonishing, and regrettable, to what extent the men who run states and nations feel that they, too, are running machines, and seek only to maintain the old thought-patterns that they used when they first learned to work the machine.

For those patterns are, generally, twenty-five to fifty years old. They are patterns formed when the automobile was young, and radio was barely beginning, before every eight-year-old comic-book reader was expected to understand what an atomic bomb was, and why uranium mines are more valuable prizes than gold mines.

It seems such a nice, safe, comfortable idea, too, to set up a good, solid authoritarian rule. Totalitarianism is a wonderful condition for the man with a rutted mind; it establishes a pattern, and maintains that pattern. It's like the good old days, when a man could learn how to plow with a wooden stick, and die watching his grandson plowing the same seigneur's land in the same way. It's so safe and dependable; it requires so little hard thinking, so few difficult personal choices. It's all laid out for you. It has the safe, steady, reliable, lack of change every man eventually achieves. Only under the glorious totalitarian state a man can be dead while he's still alive.

THE EDITOR.



GALACTIC GADGETEERS

BY HARRY STINE

*They manned the battle cruiser Sinbad — and were the most arbitrary, ornery, undisciplined, unpredictable — and also unstop-
pable! — crew that ever sailed space. But that was no accident —*

Illustrated by Rogers

Line Commander Frank Kendall, skipper of the TSN Battle Cruiser *Sinbad*, stopped as he heard loud voices issuing from the radio shack. He closed his eyes and grimaced.

"Oh, no!" he groaned. "Here we go again!"

But he didn't open the door—just yet. He listened.

"You can't do it!" Radio Officer Bill Rich bellowed. "Perfect square-wave oscillators just don't exist!"

"Oh, no?" Radar Officer Ted Anderson shot back. "All I gotta do is

generate a sine wave, clip it, amplify it, and clip it again!"

"You'll get shot-effect noise—even if you use a relaxation oscillator!" Rich retorted. "And you can't possibly clip the corners square! They've been trying to do that for hundreds of years!"

"I still say I can build a perfect square-wave oscillator!" Ted persisted.

"You're trying to do the impossible!" Rich shot back.

Ted raised his voice again. "O.K., but so did Marconi, and look where he got!"

"You've cracked your jet linings!"

Frank heard a thump, and decided it was high time he quit eavesdropping. He shoved the door open and walked in.

The two men turned. "Hi, skipper! Come on in!" Ted beckoned.

After having heard the falling body, Frank had expected a battle to the death. The falling body had been Ted's twenty-four inch slipstick which the radar man was now picking up off the floor.

"O.K., what goes on here?" Frank asked.

Rich pointed at Ted and bellowed: "That screwball thinks, he can—"

"I know," Frank cut him off. "I heard. Now heave-to and cool your tubes! I want no more battle royals up here."

"But—"

"Settle your argument. I don't care how you do it, but settle it," Frank told the two.

Bill's eyes flashed and he glared at Ted. "Are you willing for a wager?"

"If it's fixed so I can't lose. Shoot!"

"I'll bet a year of my pay that you can't develop that square-wave oscillator of yours!" Bill Rich proposed. "The skipper will act as judge."

Ted grinned slyly. "O.K., and I'll put up the same amount. Mine says you can't work out that gadget you were bellowing about yesterday: a C-plus radio transmitter that will have enough power or what-have-you to contact Terra directly!"

Frank swallowed as facts and formulas began to race through his head. The *Sinbad* was at that moment patrolling some four hundred light-years from Terra. The old inverse-square law still held for C-plus radio, and intragalactic communication was made possible only by means of several thousand relay stations scattered throughout the galaxy. Frank converted the four hundred light-year distance to kilometers and applied the inverse-square bugaboo to find the power necessary to reach that far.

The answer came out as a value of some umpty-ump-billions of megawatts of radio-frequency power.

"Yoik!" the skipper finally found voice to say. "Do you realize how much power that will take? It runs into Congressional figures! Why, you'd have to have a whole planetload of power stations and amplifiers to do it!"

Rich shook his unruly mop of black hair wildly. "Nope! Got an idea!"

Ted was unimpressed. "What you going to do, hang a hot cathode at the forward end of the main ship well, lay a few grids along the way, and end up with your plate and capacitors in the power room? You can stretch it out five hundred meters that way, and that's the only way you'll ever boost enough electrons and negatrons."

Rich shook his head again. "Nope. The rig will fit in a standard rack."

"You're nuts!" Ted shouted, then turned to Frank. "Skipper, don't you think it's time Rich had a nice long furlough before the monotony gets him? Looks like the first symptoms of space fever to me."

Frank looked coldly at him. "You're both space-happy, if you ask me." He snuffed out his cigarette in a coffee can. "I've only got one thing to say: I know you guys pretty well—you and your screwball gadgets. Just watch what you're doing. I don't want Witler and his power room gang screaming their heads off when you black out the power circuits with your short-circuit brainstorms."

"Don't worry, skipper; I'll watch it," Ted replied soberly. "I know what I'm doing!"

"That I seriously doubt," Rich commented as Frank closed the door behind him.

Nothing happened during the

next few watches, so Frank forgot about the two officers. But a coded, high-priority 'gram came in from BurGalStrat ordering all ships and fleets to the alert. Something was up, Frank knew—but he didn't know what. So he ran a few gunnery practices to give his gunnery officer, Norm Warren, a chance to scratch his itchy trigger finger.

"Secure all batteries," Frank ordered from the bridge after the last practice. He turned to his ponderous exec, Ed Henderson. "What's the time, Ed?"

Ed removed the cigar from his mouth and consulted the micro-second clock. "Point-six seconds to detect, trace, compute, swing the main DuGalds around, and get off the first salvo."

Frank scratched his chin. "Not bad," he remarked. "Not half bad. We'll do better under pressure of action."

Ed looked surprised. "What action?"

"If we ever get any," Frank added quickly. No one else had seen the 'gram from BurGalStrat. "Might as well secure. Buckle down the turrets, kill the integrator circuits, set the air, and check the course."

"At once, master!" Ed bowed as deeply as the straining seams of his uniform would permit. "Mind repeating that again so I can write it all down—*sir?*"

Frank had made a law regarding discipline among the officers and crew some time ago. In fact, it was a law which almost abolished it. He

found he could run an efficient ship without the rules and regulations of BurShips and BurPers. Frank had also made a promise about anyone who broke his regulation. Right then and there, he planted the sole of his cleated boot squarely on a well-padded part of Ed's anatomy, making good his promise. Ed tossed a rather filthy epithet toward the skipper and walked to the other side of the bridge, rubbing his injured spot.

As Frank turned to go below for a shower, Nick Stanowsky came speeding through the door aft of the bridge and collided with Frank. He regained his balance, wiped his glasses with meticulous care, and adjusted them carefully on the bridge of his nose. Then the fireworks started.

"Why haven't you checked the course lately?" the little Polish astrogator spouted. "Why, now Lawson is *four angstrom units off!* At that rate, all my calculations will be in vain, and we won't go where we think we're going!"

"Easy, Nick," Frank consoled him. "When did you catch this error?"

"Fifteen minutes ago."
"And you didn't call Lawson and let him know?"

"No," Nick admitted.
"Nick, I was in the middle of a gunnery run," Frank told him. "I can't run the whole ship; I've got to have somebody to depend on. Will you be able to replot?"

"Can I replot?" Nick said, draw-

ing himself up with pride. "Sure! I'll hit the destination right on the nose! You ought to know that by now!"

Frank grinned. "O.K., Nick. Just get back to your star tables. And keep a check on the course. After all, you're getting paid for it."

Nick mumbled something about slave labor and disappeared into his compartment.

Frank turned the bridge back over to Pete O'Malley, the missile officer, and headed aft. He passed Radar Control and spotted Ted Anderson hunched over a table twirling knobs and scanning the face of an oscilloscope with dismayed eyes.

Frank wandered in. Ted was busy with a soldering iron and spare parts. The haywire rig on the repair table nearly made the skipper sick. Tubes were scattered with wires soldered directly to the socket pins. Pieces of wire were hastily wound around terminals or attached with clips.

"What are you up to with this rig?" the skipper asked, indicating the electronic nightmare. "It looks like a rat's nest!"

"Whoa!" Ted yelled. "Don't touch! That stuff's hot!"

"You building a Frankenstein?" Frank asked, obediently putting his hands behind his back.

"Nope. I'm out to show that other jockey Bill Rich that a good radar man can develop a perfect square-wave oscillator."

"Yeah, I remember now," Frank

admitted. "Better rig that thing differently. Something's liable to arc across."

"Aw, don't worry. I fused the thing like a good Underwriters' man!"

Frank surveyed the apparatus. "Fine way to waste time. Uh, does it work?"

"Comes close to being the most revolutionary piece of equipment since the Leyden Jar!"

"How does it work?"

"Simple. Audio signal generator blowing out a nice sine-wave, pure as crystal. Scope-checked it. Here I run it through two stages of triode amplification, then clip it over here. Then she goes through another amplifier and clipper and a bunch of filters to chase away harmonics. She comes out on the scope and a ballast."

"What comes out?" the skipper asked, fascinated.

"A square-wave of five thousand cycles with rounded corners. If I can get rid of them, I've got it."

"Yeah, and how are you going to do that?" Frank chuckled.

"Frankly, I don't know," the radar officer admitted. "No tube will ever cut off that sharp due to inter-electrode capacitances. So . . . I've been playing around with heterodyning and feedback, but the only wave I get is as close to what I want as a noise-signal trace." Ted moaned.

"Looks like a lost cause, but Rome wasn't burned in a day," Frank remarked casually. "Got a schematic? Maybe I can help you."

"Schematic? I never bother with the things. The circuit drawing always runs off the paper—and, besides, I hate paper work."

Frank looked disgusted and headed for the door. He looked back at Ted and shook his head sadly, wondering if he shouldn't send the guy down to Doc Blake and have his mental marbles checked.

Bill Rich stepped out of the radio shack and stopped the skipper before he could get under way for his quarters. The radio officer quietly led Frank down the corridor and out of Ted's earshot. "Hey, skipper," he asked, "is he getting anywhere?"

"Are you worried?" Frank asked.

"I can't get started," Bill admitted, "but don't tell Ted that. I need some more information. Maybe you can get it out of BurResearch for me."

"What do you want?"

"Some dope on C-plus amplifiers."

Frank did a double-take. "Huh? Nobody knows enough about that stuff yet to amplify it—even though Evans did develop it on this ship."

"I know," Rich nodded, "but I've got to work this power boost with the principles of C-plus transmission—if I'm going to get clear across the galaxy with it. So far, you see, you've got to get all your amplification before your r-f hits your C-plus booster. You've got to feed the booster directly to the antenna because nobody knows enough about the stuff yet to lay amplification on

that side of the booster. If I can get the key and a tube that will handle the band-width at that high frequency, I'll be able to lay any number of tubes on the antenna side of the booster and get any required degree of amplification—within limits."

"Limits of the power supplies?"

"Right!" Rich agreed.

"O.K., send off a 'gram to BurResearch and sign my name," the skipper sighed, the urge for the hot shower becoming very strong. "But check through BurIntelligence; the info may be classified."

Rich stepped into the radio shack. "I'll get right on it, Frank."

"I'll be in the wardrobe in thirty minutes. Let me know how you make out," Frank told him. "And I would also suggest that you stick by your tubes and dials a little closer."

Rich looked at him. "Yeah, this patrol has been a little too quiet."

The shower felt good, but Frank couldn't get the 'gram off his mind. He wondered where the *Sinbad* would be sent this time, Trans-hub, South Galactic Frontier, Fringe Systems, or the Coal Sack Area. He sat down and began to worry it out of his system.

Four chain cigarettes later, his worries came to an end.

The intercom barked, "Skipper, this is Bill in Radio."

"What's on your mind?"

"Coded message coming down in the pneumatic tube!"

"Check!" Frank leaped from his

chair, plugged in the decoder.

The pneumatic tube went *thwoop* and the canister dropped into the basket. Frank removed the little punched card and inserted it in the machine. The decoder paused for a moment, then began to pound out the message. Frank read it line by line:

TSN BURGALSTRAT TERRA
TO ALL FLEET BASES RELAY STATIONS AND TSN SHIPS

SUBJECT ORDERS UD NAV BAND PRIORITY AAA CLASS XXX CODED ROUTE BY ALL RELAY STATIONS AND FLEET BASES TO ALL TSN PERSONNEL STOP MESSAGE FOLLOWS COLONIES IN LESSER AND GREATER MAGELLANIC CLOUDS SEIZED BY REVOLUTIONARY GOVERNMENT STOP HAVE DECLARED JOINT STELLAR EMPIRE STOP ALL TSN FLEET BASES RELAY STATIONS SHIPS AND PERSONNEL IN BOTH CLOUDS SEIZED OR BESIEGED STOP ENEMY FLEET HAS ATTACKED TSN FLEET BASE ON GALACTIC FRINGE LONG 345 STOP ENEMY FLEETS ROVING SPACE IN THAT VICINITY ATTACKING TSN SHIPS AND COMMERCE VESSELS STOP ALL OPERATIONAL BATTLE-CRAFT STAND BY FOR ORDERS STOP ALL ATTACHED

AND OR ASSIGNED PERSONNEL REPORT IMMEDIATELY TO ASSIGNMENTS AND OR NEAREST TSN BASE STOP STATE OF WAR EXISTS BETWEEN THE EMPIRE OF THE MAGELLANIC CLOUDS AND THE SOLAR COMBINE STOP VEGAN CONFEDERACY AND SIRIAN FEDERATION TO ALLY WITH TERRA STOP ALL UNITS STAND BY FOR ACTION STOP SIGNED GALACTIC ADMIRAL ERIC REINHART CHIEF OF STAFF BURGALSTRAT STOP END MESSAGE END MESSAGE END MESSAGE TSN BURCOM MESSAGE GY 28937N REF FILE 3095847-509 COPIES TO ALL UNITS TSN.

"*Whew!*" Frank breathed. "I knew it!" He switched on the intercom and threw the all-call. "Now hear this! This is the skipper. The party is over. We are now at war with a revolutionary government in the Magellanic Clouds. We've been ordered to stand by for action, so we'll go to double watch and Yellow Alert as of now. Wartime operational and security procedures are now in effect as far as they concern us. I've got the 'gram here. It will be posted, as many of you have friends and relatives who may be affected. That's all." He switched to radio. "Bill!"

"Check, skipper!"

"Stay in that shack and start tuning the naval command bands, and

don't move until I say so! Radar report!"

"Radar here!"

"All screens!" Frank snapped. "Executive officer report!"

"Bridge reporting! This is Ed!" came the reply. "What do we do now? Sit on our tails out here and let the rest of the TSN fight a war?"

"We're moving!" Frank boomed, throwing on his hat. "I'll be up in a few minutes! While I'm on my way, get Nick to plotting a course to the South Galactic Fringe. Yellow Alert and double watch!"

"What about this miserable patrol?"

"To hell with it! We're a first-class fighting ship!"

"But we ain't received our orders yet," Ed objected. "The high brass is liable to cram the DuGalds down our throats and holler 'Fire!'"

A quick smile flashed across Frank's face. "Listen, want to bet we get orders within the next three hours telling us to head into the action zone?"

"The law of probability is against me," Ed growled.

"Radio!" Frank snapped.

Rich's voice came back bored. "Radio reporting. Go ahead."

"Get on a beam to Terra! I want drive characteristics, performance figures, armament, size, and number of all enemy war craft!"

"Check, skipper. You know, personally, I can't understand all this panic. We—"

Rich had started wising-off again, so Frank lifted the switch on him.

He slid the door open and took off down the corridor. The *Sinbad* had come alive. The Yellow Alert chime was sounding through the ship, and men hurried to their stations. Frank hopped the belt-lift and stepped off on the control deck.

Things were quieter and more orderly here. Ed was a whiz when it came to organization and getting things done. The *Sinbad* was secure to move from patrol orbit, waiting only for the course from Nick. Ed was still worried, however.

"Don't fret, Papa Ed," Frank laughed.

"But I can't help thinking of that court-martial board staring me in the puss," Ed complained, his face drawn up in the perfect picture of worry. "I'll dream about it and get neurotic."

"What did you join the TSN for?"

"To loaf."

"Your shape shows it."

Ed pulled the cigar from his mouth and pointed it at Frank. "Tis better to have lived and loafed than never to have loafed at all," he announced profoundly.

Everything moved like clockwork after that. Nick shot the course down from Astrogation; Wiltner in Power said everything was secure; Pilotage reported O.K.; and Frank gave the order to move from patrol orbit.

Just as the Old Sailor was picking up interstellar speed, Radio called in. "Got your info, skipper.

I'll tape it," Rich reported.

Frank had it patched through a set of headphones on the bridge to get a small idea of what was going on. He listened for about an hour as he supervised the operations on the bridge. Finally, he pulled the headset off, walked down to the wing of the flying bridge, and leaned on the rail smoking quietly. Ed joined him, asking what the score was.

"It doesn't look too good right now, Ed," Frank told him. "The home office knew it was coming up, but there wasn't much they could do until it happened. Like the cops waiting for a murderer to strike. Looked like a small revolution at first, but I changed my mind after I listened to the reports. This time we're up against power. And, gods of space, what power! Fleet bases all over the Clouds, a big fleet, and ships that match ours in performance and fire power. Denver is just getting the fleets moving, but the enemy already has four fleets in space—to say nothing of dozens of commerce raiders on the prowl."

"What beats me," Ed wondered, blowing cigar smoke as usual, "is how they got such a large fleet in that much of a hurry, and why didn't we know about it. They didn't build all that stuff overnight."

Frank gazed out at the unwinking stars that were now slightly distorted by the *Sinbad's* interstellar speed. "They grabbed all the TSN garrisons and ships in one. *big coup d'etat*. And we had a lot of stuff out there. It's going to be a tough war,

Ed, because we're fighting our own equipment!"

Hours later, the skipper and Ed were still on the bridge discussing the situation. Nick was on the other side of the flying bridge making some star sights in his usual calm manner, but Ed was nervously chewing on another fresh cigar. The Exec had more respect for authority than anyone else on board, and he was worried about their actions.

"Skipper," he said for the hundredth time, "suppose our orders don't come through?"

Nick turned at this remark and set his novant on the chart table. "They'd better come through! I've just finished three hours of tedious calculations for the orbit to the Fringe. If we change course . . . mark my words! . . . if we change course, I'm positively going to resign! Quit! Leave! Go over the side! I mean it! I'll steal a life rocket and go home! I will!"

"Now, Nick—" Frank began.

But Nick was going into his act again. In this category, Nick Stanowsky took the green banana sandwich. And he enjoyed his pseudo-tantrums. So did everyone else. "Go on, try to appease me! But it won't work! I'll desert anyway! I have the innate ability to hit destinations right on the nose—but it takes work! Naturally, I'm never wrong, but I'm no slave!"

"Go ahead—quit!" the skipper jibed back. "We'll get there!"

Nick shot the skipper a dirty look, said something about jimmying the astrogation equipment, and tramped back to his compartment to check the course.

"I'm still worried," Ed started again, pacing the bridge this time. His shoulders hunched as though he were carrying the weight of the galaxy on them, and he nervously rubbed the sweat from his palms.

"Look, chum," Frank replied easily. "The Big Boys in BurGal-Strat probably expected us to do this. Just wait and see."

As if in answer to Frank's statement, the intercom barked, "Bridge, this is Radio!"

"Bridge, Kendall speaking. Go ahead."

"Orders from the High Brass, skipper. Rinehart just called on his own private interstellar line. He orders us to, quote, 'proceed without delay to the Lesser Magellanic Cloud where you are to engage in activities which will disrupt the enemy's lines of communication and supply. The major complement of Terrestrial and Galactic forces will rendezvous at Saggitarius 456B III in approximately one month to organize for attack. Further orders will be given at that time,' unquote. That's all there is; there ain't no more. Want to send a reply?"

Frank grinned at Ed, who blew a cloud of smoke in relief. "Tell old Iron Bottom we're on our way," Frank replied.

During the long flight to the

ASTOUNDING SCIENCE-FICTION

Fringe, Frank and his officers spent many hours studying the maps of the Lesser Magellanic Cloud and the tactical information from BurIntelligence. They cursed and discussed. As usual, no final, definite, over-all strategy was decided upon. For better or worse, believing that the best laid plans of mice, men, and the Bureau of Galactic Strategy could go wrong, they were just going to enter the Cloud, and look for some enemy ships.

One watch, the skipper was on the bridge. The *Sinbad* was just outside the galactic fringe with her crew on Yellow Alert. He walked over to the master panel, took some readings, ran them out on the integrator, and slipped the integrator's nicely-punched answer card into typer. As the typer pounded out the answer, the skipper flipped the intercom switch and yelled, "Nick! Stanowsky! Report! Jump!"

Nick looked around the corner of his compartment door and adjusted his glasses. "Did you call, skipper?"

"Yes, I did!" Frank boomed and indicated the results from the integrator. "Where in the name of dear old Oberth are you taking this boiler? Look at these course constants!"

"Is something wrong?" Nick asked as he sauntered over and glanced briefly at the results. He figured mentally. "She's right on the nose!" he smiled with satisfaction.

"What's the idea?" Frank queried. "We're not heading anywhere's near a course to the Magellanic Cloud!"



Nick smiled slyly. "Look, skipper, when you're going to slug a guy who's three meters tall and weighs a hundred kilos, do you walk right up in front of him with your fists doubled up? Not if you're going to get away with it! You see, even I have been in barroom brawls!"

Frank grinned. "I am beginning to understand. Go ahead; I like what you're saying."

"I merely looked up the info you got from BurIntelligence and found many interesting facts such as: (a) location of enemy spotting outposts; (b) locations of enemy ships computed by probability according to the last reports; and (c) locations of enemy fleet bases. I then plotted a course to take us into the Cloud—thusly."

The astrogator walked to the course plot on the aft wall of the bridge, picked up a red grease pencil, and drew a perfect spiral curve indicating the future course.

Frank stood askance and eyed it with a smile. "My sales resistance has weakened! Wrap it up and I'll buy it!"

"Fine!" Stanowsky smiled back, cleaning his glasses. "And what did you expect with the best astrogator in the TNS aboard, huh?"

Within three weeks, the *Sinbad* put light-leagues behind her as she circled in a mighty trajectory in behind the Lesser Magellanic Cloud. Finally, as the distance closed, Rich started to pick up the radio relay stations in the Cloud, and Ted began

to get echoes from enemy scouts ranging through the stars.

So the officers sat discussing the situation one night at the supper table. The coffee was out, and all officers were lounging casually in their chairs. In this manner, the brain trust of the Battle Cruiser *Sinbad* gave birth to decisions of great galactic import.

"Who's for poker?" Ed asked.

He was ignored for once.

"We'd better keep our screens peeled, skipper," Ted announced. "I've been picking up their scouts on the early-warning gear. And if we're not careful, we'll be spotted out here. We're like a black cat in the snow."

"Any heavy stuff close?" Norm Warren asked.

"I can't spot it if it is," Ted replied, lighting a cigarette.

"I think the smart thing to do," Frank suggested from deep in his chair as he stifled a yawn, "is to go ahead and barge right on in just like we owned the place."

"What if the Cloud boys spot us and realize that we haven't been included in their invitation to tea?" Bill Rich asked.

"So—we can run their tails off," Al Witrler growled.

"Or knock them out of space," Norm Warren put in.

"What if they call in a fleet?"

Pete O'Malley, the missile officer, wondered. "That is, if they spot us."

"A fleet? To stop one ship?"

Frank shot back. "Naw! Besides, the rest of the galaxy is keeping

them mighty busy on the other side of the Cloud."

Nick lifted his glasses up and rubbed his eyes. "I suggest, merely as a matter of precaution, that I obtain for future reference the plots of some of the nearer stars in the Cloud. If the entire enemy navy descends upon us, we may have to go into hiding—after fighting our way through them."

The skipper nodded, arose, and stretched. "O.K. We'll make it somehow. Right now, let's grab the chance to hit the snore shelf. Nick, you're officer of the deck next watch. Keep on your toes!"

It happened eight watches later as the *Sinbad* was twelve parsecs from the edge of the Cloud. Rich's voice boomed over the ship's intercom, "Radio to Gunnery! Target A! Target A! Red Alert!"

Frank heard it and knew at once what had happened. Rich had been monitoring the enemy radio bands and had picked up a message that the *Sinbad* had been spotted. Frank lit out on a run for the bridge.

As he stepped from the speed-lift to the control deck, he heard the whine and cough of the triple-mounted DuGald electric rifles as the turrets tracked into line. He burst in on the bridge just as the intercom broke the silence with Norm Warren's voice, "Got him! Got him, by Space! First salvo!"

"You got him nothing!" Pete O'Malley's voice cut in. "My torpedoes beat your rifle slugs to the

target! Radar will—"

Frank threw the switch and cut into the banter. "Radio, this is Bridge! Report and explain!"

"They spotted us! 'Nuf said!" Rich replied curtly.

"How many?"

"One."

Frank swore and hit the GO siren. He barked into the squawk-box, "All hands to General Quarters! We have been spotted! Engineering report!"

"Engineering here!"

"Full emergency power! Maximum circuit potential on stand by for the DuGalds! Stand by to assume flank speed!"

"Check, Bridge!"

Puffing, Ed made his appearance on the Bridge.

"Astrogation!" the skipper barked again.

"Yes?"

"Junk the old course! I want the quickest evasion course to the Cloud! Prepare for emergency battle computation!"

"O.K., O.K.! Now shut up and leave me alone!" Nick fired back. "I'm busy!"

Ted spotted them twelve long, weary hours later. The skipper was in Battle Control when he called in. "Battle Control, this is Radar! I have a contact! Ten to fifteen targets! Bearing twenty, sector lighting-able-four! Range three parsecs!"

"Battle Control to Radar. Can you identify them yet?"

"One heavy cruiser of the old *Alpheratz* Class, six destroyers of the *Nova Scorpii* Class, two *Nova Tauri* Class destroyers, and a light missile ship. No fighters in spotting range yet!"

"Attention, all divisions!" Frank ordered. "Torpedo, open up at extreme range on order! Gunnery, all turrets track on targets and fire on command! Pilotage stand by for course changes!"

The *Sinbad* pointed her blunt nose just off-center of the main formation and plunged ahead at full emergency speed. Lawson in Pilotage threw her about in an evasion course that made her old plates and beams groan in agony.

"Battle Control, this is Radar! I have targets for you! The cruiser, missile ship, and the two *Nova Tauri* destroyers are amassed in formation dead ahead. Range seventy-five meg-kilos. Six destroyers in dispersement about the flanks. Range sixty meg-kilos. Standard barrier tactics."

Small pips of light appeared on the tactical plot before Frank. He watched them move and shift. The destroyers were maneuvering for flank attacks in an attempt to slow down the *Sinbad* before she hit the main formation. The skipper watched the plot intently, then flicked the intercom switch. "Torpedo! Commence torpedo firings!"

Pete dumped four bays of sleek Mark Seventeen torpedoes with self-guiding units. The enemy missile ship replied by discharging tre-

mendous quantities of torpedoes herself, while the DuGalds on the other ships wheeled around and let go.

"Uh!" Ed snorted from the bridge. "Looks bad for the home team!"

"Shut up!" the skipper snapped. "Keep this line open and clear! Gunnery commence firing!"

Relays kicked the battle circuits on, dimming the lights, and the full complement of the *Sinbad's* batteries opened up. The flank destroyers caught the first salvoes, and the Old Sailor began to receive fire from the main formation.

A torpedo grazed aft-topside with an explosion that made the ship jerk. Automatic doors slid closed.

"Damage Control to Battle Control! One in the aft cargo hold! All secure!"

"Battle Control, this is Radar! I have three targets for you! Destroyers heading in for flank attacks! Range forty meg-kilos!"

"Gunnery, this is Battle Control! Three targets! Plots from Radar! Track and fire!" Frank ordered quickly.

The Old Sailor's turret bearings heated as Norm swung the guns and laid down a wall of fire before the enemy destroyers. They opened up at thirty-eight meg-kilos with missiles and light twelve-inch DuGalds.

Frank was tossed from his seat as the ship veered sharply to dodge an incoming torpedo. He picked himself up and strapped into his

seat in time to see five DuGald shots miss the ship by scant kilometers.

"Battle Control, this is Radar! Range to main formation is now ninety meg-kilos!"

A veritable Hell lay ahead. The cruiser had opened up with all guns while torpedoes were scattered in deadly fashion in space.

"Pilotage! Try to punch through before they bring everything to bear on us!"

"What if they flank us?" Lawson asked. "We'll get their full broadside then!"

"At our speed, they couldn't flank us for more than thirty seconds!" Frank told him.

"Huh!" Lawson snorted. "A lot of guns can be trained in thirty seconds! *Whoops!*"

The *Sinbad* jerked, and another enemy torpedo sailed safely by.

Then the screens became an inferno. Oncoming torpedoes, flashing DuGalds, and glaring explosions filled all space. There was nothing to do now but throw the whole works on autos and ram through.

But there was no noise in Battle Control. Frank jumped when Ted's voice cut in, "Radar to Battle Control! The two *Tauri* destroyers are accelerating parallel to our course! We'll have a running battle with them and their torpedoes!"

"Pilotage, this is Battle Control!" Frank barked quickly. "As soon as we make contact with the plane of the formation, change course forty-five degrees in any direction! Then outrun them!"

"Pilotage! Check!"

"Skipper!" Ed groaned. "At this speed, it'll crack the ship!"

CRUNCH!

The *Sinbad* wrenched from nose to drive orifices. Frank's senses dimmed momentarily.

"Got us!" Ed gritted. "Right in the midship life-rocket hold!"

WHAM! Over the roar of explosions and coughing of the DuGalds, the skipper heard the scream of escaping air.

"Forward DuGald turret," Ed reported. "Automatic door relays jammed." There was a pause. "The doors are jimmied! The manual controls won't close them! We'll have to cut off three more compartments with men in them!"

Frank winced. A dozen men expended to save the rest of the crew.

DuGald shots began to cross one another behind the *Sinbad* now. By pure merit of her terrific speed, the enemy's trackers and torpedo guiding units lagged her by micro-radians at the close range.

"Stand by, all hands!" Lawson's voice came over the intercom. "Stand by for change of course!"

CRACK!

The entire five-hundred-meter length of the Old Sailor strained as Lawson changed course. Men were tossed to the deck, rammed against walls, or crushed into their chairs. The old ship stayed together, thanks to her high safety factor.

Frank had a brief glance at the accelerometer needles slammed against

their pegs before he went out cold.

A call on the intercom brought him around. "Bridge to Med Section! This is Ed! Blake! Doc Blake! I—"

The skipper flipped the intercom switch. "Acknowledge, Bridge!"

There was silence.

"We're clear!" Ted shouted from Radar.

"Bridge, acknowledge!" Frank snapped again.

"This is Stanowski on the bridge, skipper. I came in when I heard Ed's call!"

"What's wrong?"

"Ed got it. He wasn't expecting the jolt. He's been tossed completely across the bridge and into the armor plate. Pretty bad. He's alive, and the medics are here."

The skipper wrote it off temporarily. He was running a ship under battle conditions. "Battle Control to all divisions! Report with damage!"

"Radio to Battle Control! All secure!"

"Radar reporting! All secure!"

"Engineering reporting!" came Wiltler's voice. "Sprung the hull in a dozen places. Losing air."

"Take over Damage Control," Frank ordered. "Patch the damage!"

"Patch? Seal-off! Can't get there for other damage!"

Reports from the other divisions poured in. The *Sinbad* could still fight if she had to.

"Battle Control to Radar! What's the situation?"

"Radar reporting! The two *Tauri* destroyers can't match our speed. They're falling behind! None of them will ever catch us now!"

Frank smiled. "Pilotate report!" "Pilotate!"

"Feed 'em star dust! Astrogation report!"

"Astrogation!"

"New course to—"

"Lawson's on it now," Nick replied in a bored tone.

"Good man!"

"Naturally!"

Battle Control was now strangely silent. The skipper opened his collar and wiped away sweat. As he tenderly felt of the several bruises on his body, he discovered that his uniform was wringing wet.

"Attention, all hands! This is the skipper! Well done! Secure from General Quarters, but stand by for possible re-engagement. We're in enemy territory now! All hands repair damage . . . and if you're as wet as I am, shower down!"

Doc Blake, the medical officer, slid the door open and walked into the skipper's quarters. Frank looked up from his desk as the Doc draped his long form into a chair.

"Hello, Doc," Frank greeted him. "Cigarette?"

Blake accepted, lit up, and inhaled deeply. He ran his slender hand over his bloodshot eyes. "Only lost fifteen men, plus those in the de-pressurized compartments. Nothing I could do to save them."

"How's Ed?" the skipper asked

anxiously.

"O.K. Compound fracture of the left arm. Spinal column severed in three places and cartilage spread all over. Got it all back together and he shouldn't be in traction more than a few days," Blake told him. "Worried more about the rougher cases."

"Such as?"

"Grafted a new leg on a turret master. Ran low on legs, and his new one is a little shorter," Blake sighed as he flipped ashes on the floor. "Going to have trouble with another man, too. Grafted an eye. His original one was blue; the new one's brown. The new one's myopic, and his other one is hyperopic and astigmatic. Going to drive oculists crazy. But what could I do? I was running out of eyes!"

Frank chuckled, then looked closely at the medical officer. The man was exhausted. "Blake, why don't you knock off? You haven't had any sleep in two days—ever since the action."

Blake shook his head. "Got men lying in sick bay who'd change your mind fast. I can't go to sleep. What price the human life?"

The skipper started to say something, but was interrupted by Al Wiltler's entrance. "Frank, I gotta talk to you."

Blake got up and started for the door. "Back to the scalpel and adhesive tape!" he sighed, and left.

"What's wrong?" Frank asked the engineering officer. "Damage O.K.?"

Al sat down and fired his pipe. "Nope. We're leaking air along seven seams, and one of those torpedoes took us in a fuel bin. We're low on air and fuel, a converter's on the bum, and the majority of our repairs will have to be done on the outside."

"That means planetary berth."

"How right you are."

"How long can we hold out?"

"Hold out? Hah! We're running on the sweat inside the tanks right now!"

Frank scratched his ear and thought for a minute. He sighed deeply. "Let's go up and talk to Nick."

Nick was wrapped up in mathematics when the two men reached the astrogation compartment. Computer in one hand and slide rule in the other, he didn't even look up from his star tables, but mumbled something about parallaxes, Class B stars, and Newton's calculus.

"How about it, Nick?" Frank asked.

Nick jumped and looked up. "Huh?"

"Found a place to heave-to yet?"

Nick nodded absent-mindedly and worked the slip stick. "Sure! Don't worry about it."

"We've got to find a Terrestrial type planet to sit down on for repairs," Al put in.

Nick started back to his figures and did a double-take at Al's remark. "A T-type planet? And where, may I ask, do I find a T-type planet out here in this mess? It's

bad enough to work with these anti-
quated star maps!"

"It's your job. Find one," the
skipper told him.

"Oh, it is, huh? Just like that!"

Nick snapped his fingers. "Orders?"
"Yes."

Nick shrugged. "O.K. Now you
guys get out of here! If I've got to
find a planet for you, I *must* have
peace, quiet, and solitude! Strain I
can take, but not noise! Nor kib-
itzers! Shove off! Scram!"

Frank was depending on Nick. He
and Al scrambled.

Four watches went by. Another
converter went out, but the *Sinbad*
was still able to make good inter-
stellar speed. The fuel grew lower in
the bins, and the air came to have a
stale quality to it.

Frank leaned against the bridge
rail, chewed his fingernails, and
tried to figure out some way out of
this mess. Witley was on his neck.
Repairs were needed badly, other-
wise the *Sinbad* might as well throw
in the towel and make ground on an
enemy planet.

Nick ambled quietly onto the
bridge and walked to Frank's side.
"Skipper, I've got news," he re-
marked casually, "I've just found a
planetary system about two light-
years away!"

"WHAT?"

"Don't yell, please. It hurts my
ears," Nick complained. "I said I'd
just found a planetary system. Like
most of the rest of this section, it
isn't charted. But it's there!"

Frank refrained from dancing
across the bridge. "Great Howling
Jets! Don't just stand there! Get us
a course for the thing!"

Nick, in addition to everything
else, was always four jumps ahead
of everybody else; he had the
course in his hand.

The planetary system was there
all right; five little planets circling
a Class M star. Al Witley nearly
went crazy with joy. Bill Rich cele-
brated in a quieter vein: he broke
out his golf clubs and started pol-
ishing up his game in the vain hope
there might be a nice nine-hole
course where they landed. The skip-
per put a stop to it, however, when
the radio officer nearly brained
Norm Warren by shooting drives
down the long corridors.

Nick celebrated quietly over a
bottle of Highland Planet Scotch.
He made some more calculations as
they neared the system, and, after
pages of higher math, stated, "Ac-
cording to my figures, which are
never wrong, the most habitable
planet is the second one. There we
will find correct temperatures, pres-
sures, gravity, and atmosphere. You
might even find life, green trees,
and grass."

"You're sure of that now?"
Frank asked him.

"Quite sure. The science of mathe-
matics is never wrong—nor am I."

Nick Stanowsky, for once in his
life, was wrong.

When Frank shepherded the big
battle cruiser into the system and
approached Planet II, Ted called

on the intercom, "Radar to Bridge.
Skipper, we got a hot reception
waiting for us."

"Tell me more, but break it to me
easy," Frank replied.

"We're about one meg-kilo away,
but I've been able to get radar-
chemical analyses of the atmosphere.
It's no garden planet! There's oxy-
gen there, all right, but also a siz-
able trace of sulphur. I hook the
bolometer to the five-inch scope and
got a temperature reading. It's nice
and warm. It's a T-type planet, all
right, but we've tangled with T-type
planets with those surface condi-
tions before. Know what I mean?"

Frank thought a minute. "Yeah.
Sounds exactly like we're about to
pay a visit to this planet during one
of its volcanic periods or geologic
mountain building ages."

"How right you are," Ted sighed.

Nick was crestfallen when they
told him. He retreated to his com-
partment, locked the door, and shut
off his intercom.

In the meantime, Lawson maneu-
vered the *Sinbad* into the atmos-
phere and went into orbit. Frank,
Ed, and Ted began to look for a
place to land. They watched the
planet through the screens and the
five-inch scope.

"I thought they converted Hell to
Diesel years ago," Ted remarked as
he scanned the landscape below.

"Holy Stern Tubes!" Frank ex-
claimed from the telescope. "That's
the first time I've ever seen a moun-
tain range shoved up before my eyes
—shoved right up from the under-

lying magma!"

"Eureka!" Ted shouted. "Here
we are! No smoke, no volcanoes, no
bad earthquakes! Take a look, skip-
per: I think I've found a place to
land!"

Frank took a look. "We'll try it.
Ed, tell Lawson to take her down!"

"I don't like this!" the Exec
mumbled as he stepped to the inter-
com.

It was a picture of Hell itself. The
Sinbad sat down easily on a broad,
stretching plain covered with a thick
layer of volcanic ash.

"Brrrrr," Ed shivered, clamping
on his cigar. "I always thought the
Moon was the most barren place I'd
ever seen!"

The *Sinbad* rocked slightly as Ed
spoke. Frank grabbed the rail. On
the horizon, the two men saw a
crimson mountain range lift toward
the sky, billowing smoke. Frank
could almost feel the heat.

"Bridge to Engineering!"

"Engineering! Witley speaking!"

"Al, this is no picnic!"

"I'm not going to waste time, if
that's what you mean!"

Blake found the air O.K., except
for a good-sized concentration of
sulphur dioxide. Al broke out the
skeeter rockets and began to search
for the ores he needed. His men be-
gan to set up cranes and scaffolding,
and started cutting debris away from
the outer hull.

As the orange sun went behind
the newly-formed range of moun-
tains, Witley and his search rock-

ets returned. The skipper went with him to the wardroom as the engineering officer wiped the sweat and dirt from his face. His lean, square-jawed face was covered with soot, save where he had worn goggles over his eyes. He pulled off his helmet and dropped into a chair. Frank got him a cup of coffee.

"Did you find iron, or thorium, or lithium?" Frank asked.

Al nodded, sipping his coffee. "All we want. We'll pull out of here with full fuel bins. But the planet is Hell, and I'm not kidding. One of the boys hung the name 'Little Hades' on it. Can't be more than a hundred-million years old. No life yet, not even protozoa. But we found what we want, and the sooner we leave, the happier I'll be!"

Even when the sun was gone, Little Hades retained its red glow. And Frank felt the *Sinbad* sway on the cooling, shifting ground. He, too, began to grow uneasy.

Bill Rich went off in a rocket the next day. When he got back, he came up to Frank.

"Skipper, look here," he said, holding out his hands.

Frank looked at what the radio officer held. "Crystals."

"Yeah, but do you know what I think they are? Iron!"

"IRON?" Frank yelled in amazement.

"Yeah, iron."

Frank looked again, and took one in his hand. They were small octahedrons about the size of a marble. "But iron doesn't form crystals this

big," he objected.

"I know," Rich nodded, "but here they are. They exhibit all the properties."

Nick looked over the skipper's shoulder. "Strange, but it could happen . . . say, under tremendous pressures and temperatures such as you would find near a planetary core."

"How many of these did you find?"

Frank asked.

"I brought back a whole sack of them, and there're plenty more where these came from. They ran in a regular vein near that mountain range that was just shoved up."

"Better get some more of these," Frank mused. "This will interest the boys back home. I don't think anybody's ever seen iron crystals this big before. Even if they're not worth a cent, we might learn something."

Rich loaded a whole cargo bin with iron crystals, while Witley's smelters, forges, and repair crews worked night and day. At the dinner table one night, Al stood up and announced, "We're just about through here, boys. Another day should do it. All damage is nearly repaired. The fuel bins are full again with lithium, and we've got plenty of oxygen in reserve. I think we'll be ready to blast off tomorrow at sunset."

That night, Frank turned the watch over to Norm Warren, who was o.o.d. for the night, and headed for his quarters. Beneath him, the

Sinbad swayed slightly once again as the ground shifted. Tomorrow would not be soon enough for Frank. He took a hot shower and went to bed. Even though the *Sinbad's* hull was triple-insulated, the heat of the planet managed to seep through, and the air system was not able to absorb it. It was a trifle warmer than usual, and that may have been the reason Frank dreamed vividly.

The skipper suddenly woke up on the floor, sweating profusely. Tremendous shocks were rocking the *Sinbad's* five hundred-meter length. They were severe, much stronger than any previous tremors. He leaped from the floor and dashed down the corridor in his skivvies.

The lift shot him upwards. He stepped on the bridge just as a shock almost turned the Old Sailor over. In the rosy light, the skipper saw the ground heaving like water. Witley's cranes and scaffolding collapsed, while the atomic smelter went up with a flash and roar.

Norm was gripping the bridge rail, white as a sheet.

"Norm!" Frank yelled. "Secure for lifting! Emergency blast-off!"

The gunnery officer came to life. "If we don't get out of here, we're sunk! The whole topography is shifting again! Bridge to Power Room!"

"Power Room! This is Witley!"

Frank stepped to the intercom and asked, "Al, can we lift ship?"

"Give me exactly three seconds!"

Norm kicked the switch, and the GG siren began whooping up and

down the corridors. The *Sinbad* came alive.

"Bridge to Pilotage! Report!"

"Pilotage!"

"As soon as you have the drive, get out of here!"

Smoke billowed about the ports as the bridge fell silent. Then, from the rear of the ship, Frank heard and felt the drive. The needles on the power meters swept across the dials. "Power Room! Secure for lifting!"

The ground was heaving up and down, splitting in wide fissures, and issuing great bellows of smoke and red fire.

The skipper felt the jets thunder and the drive take hold. Slowly, the great ship lifted clear and reached for sky.

The ground plunged itself upward less than five kilometers away, throwing molten rock and fiery ash in all directions. The plateau where the ship had lain split asunder, sending rock hurtling down into the fissure.

Frank switched on the screens to look down.

Wham! The surface of the planet lifted upwards, exposing great masses of white-hot rock and belching clouds of fire-laced smoke. The skipper had seen enough. He switched off the screen.

"Bridge to Pilotage," he called, breathing hard.

"Pilotage! Gods of Space, skipper, we got out of there just in time," Lawson's shaken voice came back.



"I know. Set a line-of-sight course for the fifth planet. By the time we get there, Nick will have an interstellar course."

"Check, Bridge!"

"Good-by, Little Hades," Norm commented. "Nick's garden planet!"

The skipper nodded, then noticed himself. He was standing there in his skivvies, his body wringing wet with cold sweat. Norm noticed too, opened his collar, and laughed. The tension gone, Frank broke out in wild guffaws at himself, and went back to his cabin.

The next three weeks were Heaven for the more bloodthirsty members of the *Sinbad's* crew. They roamed the Lesser Magellanic Cloud destroying transports and freighters, and leveling radio relay stations. She outran all the battle craft that tried to stop her orgy of hellish destruction. The free-roaming *Sinbad* was a sharp thorn in the enemy's side.

Bill Rich discovered the top-secret radio channels used by the enemy fleet. He not only tapped them for vital bits of information, but rigged his teletype transmitter to work on the secret channel. Thus he succeeded in sending many enemy units to forsaken places light-years away to supposedly search for the *Sinbad*. So the enemy fleet burned up precious fuel running out to nowhere on orders of self-appointed enemy fleet admiral, Bill Rich, gadgeteer supreme. Strangely enough, Rich still found time to fool around.

He was either seen in the radio shack with a hot soldering iron in hand, or searching throughout the ship and bothering everyone for some odd part he wanted.

Ted was deep in his own research also. He was a little less obnoxious about it all, however. In spite of the big war outside, the little war between the two gadgeteers inside the ship went on.

Then Bill Rich did it one day.

The skipper, who inevitably happened to be in the thick of these accidents, was in the radar shack with Ted searching the skies for a reported freighter loaded with radioactives. The whine of high-capacity capacitors filled the room, while the only lights were a dim fluoro-unit over the plot board and the greenish-white glow from the screens. Ted was in deep concentration, swinging his beams back and forth through the starry heavens.

Suddenly, the master screen was filled with odd shapes, wavy lines, bright lines, streaks, spot, ovals, dots, and flashing light.

"Holy Jumping Megohms!" Ted shouted. "Interference! Somebody's snuck up on us!"

Every screen in the place was jammed.

Frank leaped to the intercom to call GQ. He threw the switch and was rewarded with a squealing howl.

"They've jammed the intercom frequencies!" Frank gritted.

The fluoro-unit over the plot board flickered oddly, then Frank felt the Hansman-Wolther gravitic

units wavering and the drive jumping erratically. "Great Howling Rockets!" he gulped as the nausea from the changing fields and speeds gripped him. The color drained from Ted's face.

But there was nothing they could do. Someone—something had completely crippled the ship.

Then it stopped. The drive resumed and the fields sprang up again. The screens cleared.

Ted checked the warning sets. "Not a thing in sight!"

Frank staggered to his feet. The intercom was alive with calls which he ignored.

"What was it, skipper?" Ted asked.

"It came from the ship, whatever it was," Frank snapped. "What's Rich been up to lately?"

"I dunno, boss."

"Hold on here," Frank ordered as he dashed out the door and headed for the radio shack.

Bill Rich was seated in front of his 'type transmitter, the color just beginning to return to his face.

"What were you doing up here?" Frank asked as he shut the door behind him.

"I don't know," Rich admitted. "I just turned on the 'type transmitter and was giving phony orders as usual. Whatever-it-was got so bad that I had to turn the 'type off. Then it stopped."

The skipper put his hands on his hips. "Type transmitter, huh? What have you done to it recently?"

"Nothing."

"Some gadget in this ship is raising merry hell," Frank mused.

"I don't get it," Rich remarked, scratching his head.

"Neither do I," Frank admitted, chewing his thumb. "Whatever it was, it jammed every frequency from a-f clear on up to the Hansman-Wolther drive and gravity fields, which is some band-width, I'll tell the galaxy!"

"Some ten to the twenty-fifth-power cycles-per-second!"

Frank nodded numbly. "No present-day stuff has that band-width. Uh . . . Bill, what did you do with those iron crystals? That's the only thing on board that's out of the ordinary!"

"They're down in Hold Seven. No . . . wait!" He stood up. "I brought a bag of them up to the shack for analysis. They're . . . *whup!*" He reached up on a shelf overhanging the panel, then drew his hand away. On the shelf lay a small bag of the Little Hades' crystals. The seam had split, and the top of the panel, the shelf, and the floor were covered with about a dozen loose crystals.

Bill flipped the top of the transmitter open. One crystal had fallen through the ventilating duct at the top and was resting near the tiny output coil of the r-f stage.

The skipper saw it, too. "Aha! There, I'll wager! Don't touch anything! Get a pair of fine dividers and start measuring! Then get out your test meter and start checking values in the set . . . *after* removing that crystal to a safe spot!"

"I don't get it," Rich complained. "Nelther do I, but we may get a weapon out of this! You know what it did to this ship! Put it completely out of order!"

Bill's eyes lit up, and he went to work. The skipper was forced to leave. Ted had spotted the freighter they were laying for.

The freighter was dispatched with aplomb and swiftness.

Frank was in his quarters three hours later when Rich wandered in with a look of amazement on his face.

"Skipper," he almost whispered, "I'm a second Hertz! Another Marconi! Thomas Edison II!"

"Rich, come off it!" Frank snapped.

"But those crystals, they . . . they—"

"What about them?"

"You tell me. I can't even tack a name onto the phenomenon!"

"What phenomenon?"

Rich sat down and lit a cigarette with shaking fingers. "Frank, those crystals are going to open up an entirely new field of electronics!"

"How? What do they do, solve integrals?"

"Not quite. They may in time. But when you put one of them in a magnetic field, it gives off an electromagnetic vibration, a carrier wave!"

"Huh?"

"Yeah! The frequency is a direct function of the strength of the magnetic field. Put one between the pole of a magnet, and you get a nice,

strong carrier!"

"Even without an antenna?"

"Yeah."

"How strong?"

"I was getting the same field-strength all over the ship. It must propagate like the Hansman-Wolther stuff, at the unknown speed of gravitic propagation. But she can be detected with a simple diode detector!"

"Great Space!" Frank snorted. "We may have the answer to direct interstellar radio if those things don't pay any attention to the inverse-square law!"

"Sure. The speed of light is only theoretical anyway. Hansman and Wolther proved that years ago with the interstellar drive and such. And C-plus radio does, too. The propagational speed of gravity is the theoretical top limit now. But this is the first time anything refuses to obey the inverse-square law."

"You'll be over my head in a minute," Frank stopped him. "What made it jam all our frequencies in the ship?"

"It was beating with them," Rich explained. "That crystal was right next to the final coil of the r-f rig. Well, the teletype system modulates the carrier one hundred per cent, which means the actual current in the coil is varying from zero to its maximum value, and the field of the coil is doing likewise. The crystal was in a state of loose coupling with the coil, and when the field was at zero, or somewhere near it, the crystal did not generate. But when

the field was at its maximum strength, the crystal was whooping it up above the drive frequencies. The lowest frequency of the crystal was somewhere in the low audio. Now, skipper, you know what happened to this ship! It was completely out of action. If I can figure out a way to do the same thing to other ships without knocking ourselves out of commission, I'll have the weapon of the ages!"

"*Whew!*" Frank breathed. "Go to it! Just the perfect sort of thing for you with your lust for creating havoc with electronics!"

Rich nodded and grinned.

But Ted Anderson was having trouble. On his off-watch hours, he went to work on his square-wave oscillator. In spite of laborious calculations and sleepless "nights," he couldn't get results. After squaring up the wave, he found he had to get rid of sag and slope. He finally ended up with a trapezoidal wave.

Ted was about to throw in the towel when he remembered that a year's pay was at stake. So he decided to call on the skipper for help. Frank was all for it; the business of commerce raiding was losing its excitement.

The skull session got under way in the radar shack. Frank, as usual, was putting everything down on paper and working with a slide rule. Ted, who kept closer to electronics, was figuring things in his head and tacking elements into the circuit with a soldering iron.

The square-wave oscillator, which had started as a small five-tube affair, had grown until it covered a solid bulkhead of the shop. Racks and racks of equipment now contained so many components that Ted frankly admitted he didn't know the schematic of the whole thing. To add to this, the monster had a tremendous thirst for current.

Frank looked up from his slide rule. "Well, at least you've accomplished something—you're the first one to get real square corners on a wave. I don't know how you did it, but it's there."

"Yeah," replied Ted, disgustedly. "But my main effort is to generate a perfect square-wave. The corners are only part of it."

At this point, Bill Rich walked in. He had a broad grin on his face, and a radio chassis in his hand. Four tubes sprouted from the chassis, while power leads ran off from it. With a flourish, he set it gently on the table and rubbed his hands. He cleared his throat.

"Gentlemen," he announced, "I have here a little device which will render the spaceship obsolete."

Frank cut in wearily, "O.K., Professor Smaltz, what have you got and does it work?"

Rich grinned. "I'm interested in the answer to the last question. Let's see whether it merely blows up or just gives us a TV pattern!"

"What in the name of Deneb have you got?" Ted asked, eying the rig.

"The weapon to end all weapons—an all-frequency jammer!"

"That's impossible!" Ted snorted.

"Now run along. We're busy!"

"Wait," Frank cut in. "Let's see about this. Plug her in, Bill. I'll get George to take a life rocket out to one hundred kilos and then we'll see if we can't bollux him up."

"Only one thing I need for this," Rich said. "I gotta hook the output of Junior to the special directional radar antenna on the con tower."

Ted was on his feet. "What? You have the nerve to ask me to let you use my best radar antenna?"

"Now, now," Frank soothed. "Let the radio officer use your antenna."

Ted didn't like the idea, but finally gave in.

The skipper took a look at the all-frequency jammer. It appeared harmless enough, he decided. Rich had coupled the output of an isolated sine-wave oscillator to a little device of his own ingenious manufacture; an air-gap, iron-core, C-shaped inductance with an iron crystal in the gap. He had two big power supplies slugging the circuits with three-digit voltages.

The radio officer proceeded to hook a heavily-shielded cable to the antenna line. This done, he shoved a plug into the wall socket. "Simplest little gadget ever devised. Works off any household outlet. No Himalayan cottage can afford to be without one!"

"Life-rocket Two to *Sinbad*. Standing by at one hundred kilos," the squawk-box rasped.

"O.K., let him have it," Frank told Bill.

Rich threw the line switch. He waited until the filaments were warm, then slugged the power to the tubes.

The shielded output to the antenna radiated a weird green glow. Stuff that Frank recognized as C-plus frequencies squirted off every projection.

"Turn it off!" Frank howled as the drive, gravity fields, and screens began doing strange things again. "Turn it off."

Rich did. Things returned to normal.

Immediately, a call came in from the life rocket. "Great Jumping Jets, what have you got there?"

Frank flipped the switch. "Did it knock you out of commission temporarily?"

"Did it? *Wow!*"

"Good. It did the same thing here," a disgusted Frank replied. "We haven't got what we want yet, so come on home."

The skipper then turned and looked at the radio officer. When Frank was displeased, he didn't need to say anything. He just looked.

Rich looked back and winced. He walked slowly to the workbench, unplugged the rig, and gently fondled it. He started for the door. "Well, back to the slide rule and soldering iron!"

"Division Commander Rich!" the skipper barked.

Rich turned. "Yes, sir?"

"As far as I am concerned, you can give that gadget the deep-six. As a weapon, it's as undependable as a woman! If you can rig it so it will cook a steak, I am sure the chief cook would be deeply grateful. If you still wish to experiment with it, I will see to it that you get a nice, warm, cozy experimental station with a whole planet to yourself. But while you are aboard this ship, that *thing* will be secured safely on a shelf—unconnected!"

Rich's chin was on his chest. "Aye aye, skipper." He went out.

Ted broke into gales of laughter. "I've never seen you so mad, skipper!"

The skipper lit a cigarette; there was no trace of anger left on his face. "His experiments were going too far. He'll be a bit more careful the next time he tries it out—and he'll work like crazy now to figure out a way to make it work!"

But if Bill was working on his gadget, he didn't say anything about it. Having incurred the wrath of his skipper, he performed his duties with tremendous vigor. But Frank knew he was thinking about his gadget.

One day, Rich pulled a message out of the receiver that was monitoring the enemy intelligence band. He decoded it and brought it promptly to Frank. The skipper read it and called a meeting of all officers.

The wardroom was the usual hub-bub of noise and smoke by the time Frank got there. Coffee cups were in

their usual prominence, and the officers were slouched normally in their chairs with their feet thrown up on the tables.

The skipper held the radiogram in his hand and stood up. Silence fell as the men waited for the word.

"This message came in on the enemy radio an hour ago. The enemy has received reports of a TSN battle fleet concentration in the vicinity of Saggittarius 456 B. This confirms the information we received in our orders. Our orders implied, furthermore, that we were to raise as much hell as possible with the enemy's fleet movements. Any suggestions? Discussion?"

"The attack's a month late," Nick Stanowsky observed. "And it just so happens that we're not far from where the two fleets will most probably engage."

"How long will it take us to get there?" Ed asked.

"Four days," Nick replied, figuring mentally.

"Let's hit them from the rear," Norm Warren suggested.

"O.K.," Frank cut in. "But we've got to make some plans. I'm going on the assumption, as I always have, that all of us can come up with a better plan than just one man. Let's discuss."

"I think we should get an idea of the course of action before blasting in," Al Witley spoke up.

"Logical," Pete O'Malley mused. "That way, we can judge where we can come in most useful."

Ted jumped up. "Why don't we

search out the enemy fleet, then fall in with them—maybe in a connecting file, or something. They probably won't spot us because they'll be plenty busy with our boys. Besides, we're wise to their communications bands; we can shoot them phony ID signals."

"Fine," Ed nodded.

Rich coughed. "What about . . . the gadget?"

"I'm afraid not, Bill. It's too demoralizing on our own men here. We'll only use it as a last resort." He paused and looked around. "O.K., start planning with your respective divisions. You all know what we're going into. We'll be one against ten thousand. It'll take every bit of courage we've got. Let's go!"

There was little sleep obtained among all members of the crew. They secured at GQ and Stand-by, and stayed there. The skipper spent the sleepless watches in a constant journey between Radar, Radio, Bridge, Battle Control, and the wardrobe for coffee.

Ted had the early-warning screens going, and picked up units of the enemy fleet on their way to rendezvous. The *Sinbad* followed them, cautiously skirting the extreme range of the enemy detection gear. Frank took up permanent residence in Battle Control to watch the plots.

The tiny lights moved slowly through the globular plot. As the ships they stood for began to take position, Frank got an idea of the

enemy strategy. The TSN invasion fleet would be met by a decoy force, and the advance TSN units engaged. The main enemy strength was concentrated on one flank and would strike the TSN force from there.

Plans changed on board the *Sinbad*. The Old Sailor would hit the main enemy force from the rear in hopes of breaking parts of it up. This involved crossing behind the decoy force well within their detector range. Timing had to be perfect; the big battle cruiser had to hit the enemy at the same time the latter hit the TSN. It would be tricky with a ship the size of the *Sinbad*. It meant they would be spotted for sure.

Equations poured down from Astrogation. Tracks and positions from Radar kept the little lights in the plot moving constantly. There was a strained, tense silence throughout the ship. Men stood by their panels, turrets, torpedo hoists, and meters trying very hard to look calm, but they weren't.

The intercom in Battle Control barked. "Radio to Battle Control!"

Frank jumped and flipped the switch. "Control. Kendall speaking. Go ahead!"

"We have been spotted by an enemy security patrol of six destroyers! They are requiring identification!"

"Radio, use Plan Gamma! Report the reply!"

"Aye, Control!"

"All hands! This is the skipper.

We have been challenged. Torpedo stand by. Gunnery track."

Up in Radio, Rich pounded out a message and coded it. His 'type transmitter clacked a few times, then fell silent. The message was gone; the *Sinbad* had acknowledged as the Battle Cruiser *Acherner*, captured at the outbreak of hostilities, of the same size as the *Sinbad* and using the *Sinbad's* type of lithium drive.

"Radio to Control. Enemy has acknowledged us as the Battle Cruiser *Acherner*. We're supposedly late for lunch!"

"Radar reporting! Security patrol accelerating in spiral to Sector Crimson!"

The next twelve hours were tense. The enemy reported initial contact with units of the TSN. The enemy fleet whipped into action. The spots of light on the globe changed position with alarming swiftness.

"Control, this is Radar! Four strong security patrols are deploying from both formations. The main enemy force will hit our boys in five hours. In the meantime, those patrols will pass us!"

"All right, Radar. Control to Astrogation. Nick, figure a way to get us out of here. I don't want to be spotted by those patrols. They're coming close, and the chance is too great!"

There was a short pause.

"Astrogation! Acknowledge Control!" Frank snapped.

"Astrogation to Control! I'll get your course if you'll tell me *how* to

get out here!"

Frank jumped. "Radar, this is Control! Get me a course integration on those patrols!"

Another pause.

"Radar reporting! Skipper, they are all on collision courses or flanking courses with us. One patrol is due to cross our bow in a few hours! Hold it! I'm getting more plots! Four more units have taken attack courses! Gods of Space! Five battle cruisers with them! They're converging on us! I'll—"

Ted was cut off by another voice, "This is Radio! Give me the line! Crash priority! Hello, Battle Control!"

Sweat began to break out on Frank's forehead. The short hairs on the back of neck began to itch. "Go ahead, Radio!"

"Control, this is Radio! A message from the enemy to the *Sinbad*! They have spotted us, are surrounding us, and order us to surrender or be blown out of space!"

Frank growled: "Radio, did you give them the right coded ID signals?"

"That I did! For the Battle Cruiser *Achernar* of the same classification as the Old Sailor!"

"Something slipped!" Frank replied. "But what happened?"

Ed's voice came back from the bridge. "You want to know? I just checked. The *Achernar* uses a lithium Hansman-Wolther drive—"

"But that's what we've got!" Frank objected.

"Sure, but take a look at our drive

trail through a drive spectrum detector. You ought to know what that is; it was developed right on this ship! A lithium drive works on pure lithium and a drive trail will show that. But we picked up our lithium on that volcanic planet, and our drive trail had traces of lithium sulphate in it!"

"But the stuff we got on Little Hades was pure lithium!"

"Frank, I was once a power officer. And to anybody but a power officer, that would've been pure lithium. But little traces that just barely jiggle a spectroscope while the stuff is still unconverted fuel will stand out like a black cat in a snowbank after it's been put through a converter! In other words, we cooked our own gander!"

"So that's it!" the skipper gasped. "The enemy knew all their ships out here had been fueled with pure lithium! When our drive trail showed something different, they got wise!" He grimaced, scratched his ear, straightened up, and flipped the all-call. Skipper Frank Kendall was mad now—and determined. "O.K., so we've been caught. Radio, this is Control! Send this reply to the enemy: Tell them if they want us to come and get us. But warn them that someone is going to lose, and that we hadn't planned to!"

"Radio to Control! Check!"

Nick reported that they had a little over four hours before the first enemy ships would make contact. Frank set the Astrogator at the task of computing an evasion course that

would offer the least probability of being hit from two sides at once. Pete O'Malley and his sweating torpedomen loaded every available torpedo into every nook and corner of the launching bays. Norm Warren kept his turret masters swiveling the turrets to keep the bearings warm, checked his integrators and trackers a hundred times, and threw in extra overload circuits. Everywhere, the preparations went on with equal care and thoroughness. There was no more bunter. Except for the activity, the ship was quiet.

Frank and Ed went into deep conference with Ted in Battle Control. From the great lighted screens, they watched the positions of the enemy and began to figure a defense. Bill Rich entered while Frank and Ted were busy over the master tactical plot.

"Skipper, I've got to talk to you," the radio officer said.

"What about?" Frank asked, not looking up.

"The gadget, the all-wave jammer."

"We can't use it," Frank told him. "Nobody likes the effect it has on this ship."

"But that's just it, skipper! I've got a way figured out, but I've got to have some help."

Frank straightened up. "Such as?"

"A square-wave oscillator," Bill said slowly.

Ted jumped. "A WHAT?" he roared.

"Your square-wave oscillator,"

Rich repeated. "I want you to help me with this. I need your oscillator that gives square corners. And it's going to take two of you to rig it up!"

"What do you have in mind?"

Frank asked, suddenly interested. "I've been thinking things over since my last fiasco," Rich told him. "I've even hooked up some experimental rigs with that little test oscillator I've got. My tests worked fine, but I've got to have a good oscillator for large-scale operation."

Frank thought for a minute, nervously chewing a stylus. He made his decision and turned. "O.K., Bill, go ahead! If you can get it working in three hours, you're free to try it!"

Rich looked at Ted. "Well?"

Ted picked up his cap. "O.K., let's go up to the shack and talk this thing over."

During the next hour, Frank noticed great activity between Radio and Radar. Huge pieces of equipment made the floors vibrate as they were wheeled from one spot to another. Wires lay in great tangled messes along the floor of the control deck between the two establishments. The two gadgeteers dashed wildly about and made no end of trouble for the rest of the crew. Witley's domain in the Power Room was invaded, and the great power-control boards were ripped into and left with big black cables strung out of them in haywire fashion.

Witley was griping as usual.

"First, they want a thousand-meters of Number Eight insulated wire, then a hundred-meters of shielded co-ax. They made off with ten kilograms of Alnico metal and three-hundred-fifty meters of quarter-inch copper rod. Space knows what they've gone and done to the power supplies!" he griped over the intercom. "I want to know who turned them loose!"

"Does it look like they know what they're doing?" Frank asked.

"Frankly, no! I've never seen such haphazard stuff! They didn't even bother looking at the ship's electrical schematic! They just went ahead and diddled until they found what they were looking for, and they've had my welding crews going mad. They've got four cables welded onto the main ship bus where it goes under Radar Control! And my power boards look like a bird's nest! Spaghetti all over!"

Two hours of wild haywiring elapsed before Bill and Ted called in and reported ready. Time was getting short, and Frank didn't have time to check what they'd done.

Thirty minutes later the first contact came. A destroyer squadron ripped in off the port side and made a torpedo run. Norm Warren whipped his batteries around and opened up at extreme range. Frank felt the ship shudder as salvo after salvo was fired.

"Yak yak!" Norm chortled over the intercom. "Skipper, we got the space rat! Two of them! They'll think twice before they underesti-

mate the range of these batteries again!"

A fighter squadron slipped in next.

"Radar to Control! Targets for you! Fighters making saturation attack!"

The fighter squadron succeeded in peppering the *Sinbad* with light Du-Gald fire which inflicted little damage to the *Sinbad's* heavily armored hull. They lost ninety per cent of their number under Norm's murderous wall of fire and left in a hurry, being chased by a dozen of Pete O'Malley's fast torpedoes.

Frank checked the damage and realized that the *Sinbad* could not hold off hit-and-run attacks forever. "Radar, this is Control. Secure the gadget for action."

"Check, Control. Radar standing by."

"Choose your targets and fire at will. Gunnery and Torpedo stand by to execute Plan Zebra!"

A fast cruiser and five destroyers hit from two sides at once. Norm and Pete opened on the cruiser.

The destroyers came on unmoles- ted.

Frank breathed a prayer. He glanced at the power-demand meters and saw the needles swing past the red lines. From the rear of the ship came the tortured whine of overloaded generators.

The skipper waited for the crash of the giant breakers in the Power Room; for some unknown reason, they didn't throw under the terrific

current drain. When he finally got the nerve to look at the screen, the five destroyers had ceased fire and were plunging recklessly about in space. Their drives were blasting irregularly, and from all protuberances a weird greenish point-discharge sputtered. Two ships collided and vanished in a billowing cloud of fire.

"Gunnery, this is Radar! *Shift!*"

In answer to the intercom call, Norm swung his guns from the cruiser and brought them to bear on the floundering destroyer squadron; blasting the helpless ships mercilessly. Then Frank saw the cruiser go out of control.

"They got it working!" the skipper yelped, leaping from his seat. The plot technician peered from his post behind the globe, wondering if the skipper had been subjected to too much strain. "They got the jammer working!"

The intercom growled, "Control, this is the Bridge! What is going on?"

"They got the jammer working, Ed! Look, a whole destroyer squadron, plus a cruiser!" Frank fired back.

"The jammer? The gadget?" Ed asked in disbelief. "But what happened? The last time they tried that thing, the ship—"

"They've been gadgeteering! Take over for a minute. I'm going up to Radar! Command from there! Have Channel B patched through for command circuit!"

"But you can't leave your post!"

the Exec objected. "We're in combat! This is a fight!"

"Fight? This is no fight from now on; it's a slaughter!" the skipper laughed, unstrapped, and dashed out the door.

In radar, Bill and Ted were having a circus. The skipper was amazed at the sudden order of things. The compartment was still littered with electronic components, and there was hardly room to stand for all the equipment. The two young men were like kids with a new Junior Atomic Kit. Frank stood patiently by while they explained the rig.

"In a nutshell," Bill explained while Ted watched the screens, "we've got two square-wave oscillators up here putting out the most perfect square-wave Ted was able to get. One of them is feeding the main ship circuits. You've still got sixty-cycle current, but it's modulated with a hundred-megacycle square-wave—which nobody will even notice. Then the other oscillator here runs into our own supply lines and through a sync-circuit so it's in phase with the power-line pulse. Then she goes through a modified reactance-tube modulator which puts the power to the gadget one hundred eighty degrees out of phase with the pulse in the main lines. You might call it 'time-rate-of-change pulse.'"

Ted didn't look up from the screens. "So when the pulse in the main lines has the current and voltage at zero—off, in other words—the



out-of-phase pulse slugs the juice to the jammér. She can't hurt the ship now. All the circuits in the ship are off when it's on. She's shielded five-ways from Ganymede to the antenna, which is highly directional. The selsyns on that antenna are coupled to the tracker circuits on one of the gun-director radars."

"So when a ship comes in," Bill cut in, "Ted spots it, kicks in the tracer circuits, and the rest is all automatically computed and tracked.

When we're good and ready to give the old boys the thrill of their lives, Ted signals me and I kick the switch—and the gadget does the rest!"

"This guy's energetic," Ted mumbled. "I wanted an auto-relay to kick the jammér on when the target got within a certain range. But no, he has to keep his hands and brain busy!"

After crippling three destroyer squadrons and blasting two more cruisers galley west, the skipper de-



cided to go on the offensive. They sailed in behind the main enemy formation and began to raise their own, unique, particular brand of Cain.

Fleet Admiral Wharton P. Baggs, commander in chief of the Fourth Fleet of the Terrestrial Space Navy, and supreme commander of the Combined Galactic Space Force, couldn't believe his eyes. On the screens of his flagship, the *Oberth*,

he watched the entire center of the enemy line collapse.

"Technician!" he bellowed. "Check these screens. They're haywire!"

The technician made a hasty check. "Nothing wrong, sir!"

* "Come here, Andrews!" Baggs bellowed at one of his aides. Fleet Marshall Andrews was quick to obey. Baggs jabbed a finger at the screens. "Look—and don't tell me you don't see it!"

Andrews gulped. "Their center is

folding like a wet rag!"

"A stroke of luck, Andrews! Send in Task Force Xenon! Maybe we can remove that threat to our flank! Move!"

"At once, sir!" Andrews said as he moved—fast.

Guns bristling, Task Force Xenon hit the enemy center. The entire Task Force went suddenly out of control. All radio contact was suddenly and mysteriously severed by terrific interference.

"What the blazes!" Baggs roared. "Don't those oafs know how to handle ships! Andrews! Call the Bridge! Gather my escort and Task Force Jupiter! We've got to take advantage of this!"

The TSN Fourth Fleet broke and regrouped. The *Oberth* and her escort thundered toward the breach. Suddenly, the screens showed something new.

"Ship coming through the center, sir!" Radar reported. "Bearing oh-oh-four, oh-three-two. Range ten megkilos."

"Order Attack Group Four to take it out!"

The technician on the identification equipment turned white and checked again. "Admiral! That's the Battle Cruiser *Sinbad*!"

"Impossible! She was lost in action!"

"No, sir! That's her! No question about it!"

"Have Radio contact her! Tell her to move over! She must have opened this formation from the rear! They—"

Baggs didn't finish. The *Oberth* started cutting up like a young colt. The screens went dead; the intercom let out a squealing howl and quit. The drive bucked, then went out of control; DuGald turrets stopped in mid-swing as their charges sputtered off the capacitors. A greenish discharge spurted from every object with sharp corners. Baggs was alternately pinned to the floor, floating free, and thrown against the walls.

The *Sinbad* came plunging on without firing a shot.

"O.K., Ted, cut her off," the *Sinbad's* skipper instructed. "We've broken the formation. Now let our boys come through."

The *Oberth* and escort returned to normal with a jerk. The crews picked themselves up, passed out dichlorosynapine for space sickness, then went groggily through.

Wharton P. Baggs was flabbergasted. In all his thirty years as an officer of the line, in all the battles and engagements he fought, he'd never had anything like that happen to him. It scared him perhaps worse than it did his men, and the crews were pretty demoralized.

The *Sinbad* and the *Oberth* passed within three thousand kilos of each other, and the *Oberth* opened communication.

OBERTH TO SINBAD REPORT
SINBAD REPORTING
FLEET ADMIRAL BAGGS TO
LINE COMMANDER KEN-

DALL STOP WELL DONE
STOP YOUR ACTIONS IN
OPENING THE FORMATION
HAVE GREATLY AIDED THE
TSN STOP SHALL PERSON-
ALLY RECOMMEND YOU TO
DENVER IN REPORT STOP
IN VIEW OF YOUR EXTEN-
SIVE OPERATIONAL PERIOD
YOU MAY RETURN AT ONCE
TO THE NEAREST FLEET
BASE STOP OVER.

THINK WE WILL STICK
AROUND STOP MAY BE ABLE
TO HELP YOU WIND THIS
UP IN A HURRY STOP KEN-
DALL

GOOD STOP JOIN SECOND
WAVE STOP BAGGS.

ARE NOW IN SPIRAL
CURVE STOP IN THIRTY
MINUTES WE WILL OPEN
ANOTHER HOLE TO YOUR
RIGHT STOP HAVE UNITS
FOLLOW US THROUGH STOP
KENDALL.

JOIN THE SECOND WAVE
STOP BAGGS.

ALREADY IN CURVE STOP
WILL KEEP REST OF ENEMY
BUSY FOR YOU STOP KEN-
DALL.

JOIN THE SECOND WAVE
STOP ORDERS STOP BAGGS.

SINBAD UNDER DIRECT
GALACTIC GADGETEERS

ORDERS FROM BURGAL-
STRAT STOP WILL REPORT
AGAIN IN THIRTY MINUTES
STOP WATCH OUR DUST
STOP KENDALL.

YOU ARE DISOBEYING OR-
DERS STOP JOIN THE SEC-
OND WAVVVVVVVVV.

Bill Rich lifted the switch on the 'type receiver and cut the connection. Frank turned and laughed. "O.K., boys, the TSN and Admiral Baggs are going to see the little gadget in action. Keep it hot!"

The *Sinbad* swung around and opened another hole as if by magic. Crippled enemy ships floundered about to be finally knocked out of the skies by Norm Warren and the TSN units that unquestioningly dogged the *Sinbad's* heels. The story of her return from the dead from behind the enemy lines and the way in which she had opened the enemy formation from the rear spread through the fleet like wildfire. And the TSN boys didn't mind following her at all.

What they couldn't understand was the way that enemy ships floundered ahead of her before she ever fired upon them.

The First Battle of the Clouds became a turkey shoot. It was wholesale slaughter. Invisible hands reached out from the Old Sailor and smote every enemy ship standing in the way. After easily punching the second hole, Nick put the big battle cruiser into a curve which

terminated in contact with the enemy reserve units. By the time the *Sinbad* had suitably scattered and weakened that force, TSN ships were behind the enemy on every quarter.

The enemy turned and tried to run. It was like shooting bottles off a fence.

Nine watches later, the *Sinbad* made ground on one of the fleet bases the TSN had captured from the enemy in the push. Lawson cut right through the heavy traffic above the ramps, then greased her down easily. Frank made a requisition for supplies, armament, and fuel, then settled down to supervising the loading.

The sunlight on the little planet was warm, and the fresh air felt good to Frank as he stood on the walkway outside the bridge. He had just lit a cigarette and settled down to enjoying the sun when the intercom barked for him. He swore, walked inside, and answered it.

"This is Norm at the lower lock! Hey, quick! How do you pipe an admiral aboard?"

"You've got a book somewhere! Look it up!" Frank replied. "Who is it?"

"Baggs!"

"O.K. Tell him I'll be serving tea on the bridge!" Frank told him and cut off.

Norm cut right back on. "But you're supposed to meet him! Says so right here—paragraph 419-B, TSN Regs!"

"I'm on the bridge and can't leave; I'm busy," Frank shot back. "See paragraph 456-N. Send him up!"

Baggs got lost on his way up and took his time. Frank saluted him when he finally appeared on the bridge. Baggs returned the salute and clumped to the edge of the bridge. There was fire in his eyes, but his voice was low. "Congratulations, commander. You are to be complimented. I have personally recommended your entire crew for the Legion of Space medal for their bravery."

Frank smiled. "Thank you, admiral. Most of the men will be glad to get another one."

Baggs snorted. "However, there is one small item upon which you deserve severe reprimand. You deliberately disobeyed my orders during the battle, but due to the circumstances, I shall ignore it. But, during the last few months you have either captured or developed a new method of attack, have you not?"

Frank bit his lip. "Aye, sir. An electronic weapon."

"It worked admirably as a weapon, too," Baggs glared, trying hard to hold his famous temper. "But you don't use a weapon against your own forces, do you? Of course not! He was fairly spitting out his words. "Then why did you use it on me?"

Frank replied very innocently, "Sir, we just didn't know you were in range."

"You had detection equipment, didn't you?" Baggs shot back. "I

would like very much to see this weapon, since I have experienced its effect."

"Sorry, sir," Frank told him quietly. "We can't. BurGalStrat has instructed me to keep it top secret until we can get it to BurResearch on Terra."

Baggs anger faded; he smiled. "I see. Well, I shall also recommend its use as a weapon in my report. You did a fine job with it. Fine job!" He looked around the bridge. "This is a fine old ship—a dependable ship."

"Would you care to look her over, admiral?" Frank asked cautiously.

"No, thanks. What I really would like to see is that weapon, but there's no hope for that. Would you and your executive officer care to join me for a drink at the Officers' Club?"

"Thank you, sir, but I'm afraid we can't," the skipper replied. "As soon as we finish loading, we have orders to lift ship for Terra."

Frank accompanied the admiral to the lower lock making small talk about hulls, turrets, and torpedoes as they went. As he finally watched Admiral Baggs climb into his car and drive off, Ted came up and leaned against the lock door.

"Skipper, you know I think he got the idea that we had our hands on a perfect weapon. Well, it's a good weapon, all right. Too bad there's a defense for it."

"Huh? A defense for the jammer?" Frank asked incredulously.

"Yeah. You see, Bill and I got to

diddling after the battle, and we figured we'd better have some sort of defense just in case. So we worked it out. The minute that jam hits the ship, a receiver picks it up and discriminates the hundred-megacycle pulse. A trigger circuit then fires off a square-wave oscillator in the ship under attack, and a reactance-tube modulator puts the ship's power supplies out-of-phase with the incoming pulse. Nothing to it! Didn't even jam the life rocket at a hundred kilos!"

Frank breathed a prayer to be protected against the antics of all maniac gadgeteers, and turned to Norm Warren. "Let me know when you're ready to lift ship," he told the o.o.d., then turned, went to his quarters, and took a healthy swig of some Highland Planet Scotch he'd filched from the Astrogator.

An argument was taking place within the hallowed halls of the Bureau of Galactic Strategy. Not that differences of opinion were not prevalent here, but it was a novel thing to have the Board of Galactic Strategy consisting of five full Galactic Admirals differing violently about only one ship.

"But Baggs' report says almost exactly the opposite thing from Kendall's of the *Sinbad*!" Galactic Admiral Williams maintained. "Something's wrong somewhere!"

Mohr, who was defending the *Sinbad*, quietly shrugged. "I know where it is. Baggs said the *Sinbad*, under his direction and orders, used

the weapon they developed and succeeded in punching holes in the enemy. Now, gentlemen, I know Baggs better than that. And, more important, I know the boys of the *Sinbad*."

"All right, explain it, then. Kendall says that after Baggs ordered them to withdraw from the battle, they told him they were not operating under his orders. So they just went over his head and took matters over. Do you know what that is? A measly Line Commander telling a Fleet Admiral where to head in?"

"Of course," Mohr smiled, "but they were not operating under his jurisdiction, remember? It'll be a cold day on Mercury when Kendall runs from a good fight."

"The main argument is which report to believe. I'll take Baggs. He's the man in charge. But in the meantime, if the *Sinbad*'s report is correct," Williams pointed out, "it means they've broken every blasted law in the TSN Regs! That's why I can't condone their actions. Baggs was the senior officer in charge."

"That has nothing to do with it," Mohr put in.

"How come you're going to bat for them? What's your vested interest in that ship?" Williams asked.

"You forget, Williams," Mohr replied, calmly lighting a cigarette, "I was once commander of the *Sinbad* myself. That shouldn't have anything to do with it, I agree—but I was once a part of the *Sinbad* Project, and I want to see it go on.

Something like you're advocating would either stop it dead or seriously slow it down!"

"Slow what down? Mohr, they're a menace to planned fleet operation! Every time we turn around we get reports of how they've generally fouled up TSN strategy!" Williams shot back, on his feet.

Mohr stood up too, and leaned over the polished table. "Williams, if they hadn't been out there fouling up the strategy in the First Battle of the Clouds, Baggs might well have lost the entire Fourth Fleet! They saved that lunkhead's neck and star! And they did it with a new weapon which may well revolutionize spatial warfare!"

"A new weapon! *Pfagh!* So what? The job of the TSN is to fight and protect! Not sit out in space and gadgeteer! We have labs for that purpose!"

Mohr sat back down and flipped ashes. "We have labs, of course! But we aren't going to win this war, or any other one, unless we have a technology better than our enemy's! The *Sinbad* is the key."

"All right, what is this *Sinbad* Project?" Williams asked.

"Williams, kindly sit down," gray-haired Admiral Rinehart, the biggest man in the TSN, remarked. Williams sat. "You should not be in BurGalStrat if you do not know the *Sinbad* Project. It is this: Each man on board the *Sinbad* has always been picked for one thing, brains! You and I know the best brains in the world have always been misfits

—unless they're in an environment where they aren't pink monkeys among brown monkeys. There on the *Sinbad*, every man from the lowest spaceman on up is, literally and figuratively, a genius. The lowest IQ in the group is 144, and they're all of personality type Alpha-Seven or Theta-Nine—independent as all get-out! They're in an environment all their own; we see to that. And they're given as much free rein as possible. We set up problems for them, barriers which they must overcome and which are a challenge to them. A twentieth-century psychologist, Kurt Lewin, showed that more can be accomplished when the atmosphere is highly democratic. We can't get that in our labs, so the *Sinbad* became our roving lab almost fifty years ago. In that time, they've solved some knotty problems. They came up with C-plus radio, disrupter torpedoes, drive analyzers, ship identification by radar, and a crack-proof radio code system. Now they've got the all frequency jammer. They've not only worked these things out, but applied and tested them at the same time. The result is that we now have the best space navy in the galaxy.

"None of them know what is going on. And when they run out of inspiration, they're given top-jobs in BurGalStrat or BurResearch.

"In a few years, they'll lick the biggest problem of all: direct intragalactic communication. As a matter of fact, Mohr reports they're working on it now!"

Bill Rich was.

The *Sinbad* was fifteen watches out of the fleet base on her course to Terra. Ed was in his favorite position, leaning heavily on the bridge rail surrounded by cigar smoke. Frank finished checking the master panel and turned to the Exec. "Cup of coffee?"

"Now, I'm thinking!"

"Why don't you do something constructive?"

"Can't start a poker game," Ed replied. "We ain't been paid in six months."

Frank sighted down the bridge rail. "Have to get that straightened where you've been leaning on it."

"It's comfortable the way it is. Why bother?" Ed blew smoke.

The skipper tossed his notebook on the log table. "I feel the urge for a hot shower." He strode out the door and down the corridor.

He was stopped by loud voices issuing from the Radio shack. "Oh, no, not again! Please, not again!" he moaned and went in.

This time, Bill had something in the rack panel he was defending.

"O.K., boys what is it this time?" the skipper asked wearily.

"Remember our bet?" Bill asked.

"How could I forget?"

"I just won!" Bill proudly announced.

"Not until you prove it works!" Ted yelled.

"What have you got?" Frank asked in a bored tone.

"The trans-galactic radio has arrived!" Bill announced proudly.

"Will it work?"

"Don't know. I was going to ask you if you want to be the first one to try it."

"How does it work?" the skipper asked.

"Well, we know the iron crystal will generate an e-m radiation whilst in the presence of a magnetic field, and that the frequency is dependent upon the field strength of the magnetizing unit. Now, by merely tacking a few more tubes in the circuit and adding an audio section, we can modulate the carrier with FM. Any FM set should pick it up. According to my calculations, I should be sitting right in the middle of the TSN's terrestrial band." He picked up the mike. "To hell with 'type stuff'; this is going to be voice transmission. Skipper, you will have the honor of being the

THE END



ASTOUNDING SCIENCE-FICTION

first voice to be heard across the galaxy!"

Frank took the mike gingerly. Looking furtively at the rig, which was a typical Rich haywire job, he asked, "Are you sure this will work?"

"Absolutely!"

"O.K., nothing ventured, nothing gained!" the skipper sighed. He pushed the mike button.

He started to say something, but didn't. The whine of overloaded generators came from somewhere, and the smell of burning insulation filled the air. A capacitor arced across and melted. From the panel came a brilliant display of electrical fireworks.

Circuit breakers threw with a mighty slam, and darkness closed in.

There was deep, undisturbed silence for fully thirty seconds. Then, from the darkened Radio Room of the *Sinbad*, the tired voice of Skipper Frank Kendall burst forth sarcastically.

"Anybody got a candle?"

SUCCESS STORY

BY JULIAN CHAIN

A beautiful, bitter story — and the conquest of space depends on more factors than mere technical science. One idea, and a faithless love can twist the course of Man's destiny — if the Fates fall wrong!

Illustrated by Orban

After several centuries of study, this planet, discovered by Irredelian explorers within the last millennium, still remains an unsolved problem in planetary history and civilization. We have seen in our own history and in those of all extra-Irredelian societies with which we have made contact, an almost uniform progression of events. First: The appearance of a species, the evolutionary response of which is intellectual, rather than physical, specialization. Such a species becomes organized culturally into primitive groups with highly naive views of nature. These cultures interpret the external environment as an extension of themselves, and people inanimate nature with hierarchies of spirits and gods to be compelled by magic and ritual. Inevitably they are thus arrested by becoming close-bound in an unbreakable web of convention and tradition. The next phase is initiated cataclysmically by a successful response of one such society to some major environmental change. The resultant struggle for survival dissolves tradition and leads to a more accurate understanding of the en-

vironment. The spirits abdicate in favor of physical laws and relatively complex technologies are developed. The society, now become a civilization, throws off offshoots and successors. One of these enters a phase of scientific development and emerges with tools so powerful that, by force or example, it quickly dominates the planet. In this phase physical science progresses at ever increasing speed while the more subtle biological disciplines lag behind. Nuclear physics achieves first heavy atom fission and then the synthesis of heavy nuclei from hydrogen. With the energy thus available, the civilization erupts into space.

The planet under discussion remains the single exception to the scheme outlined above. This planet, populated by an unusually vigorous and intelligent species, was discovered in an apparently primitive and almost Arcadian state of development. The observation that the culture was world-wide and that the population was far greater than a primitive economy could support led to further studies by subsequent expeditions. It was soon discovered

that this society was far from primitive and was, in fact, supported by the most highly developed science of plant biochemistry in the known universe. For some time it was thought that in this case the biological sciences had preceded and outrun the physical. Doubt was cast on this theory by survival of ingenious, although abortive, applications of atomic energy. Further studies deepened the mystery. It was found that the development of this civilization was in all respects parallel to the general scheme. Several millennia before its discovery, this species had entered the last phase of the efflorescence of physical science. The essential mass-energy equations had been formulated and refined. Nuclear fission and fusion had both been achieved. A vast and complex physical technology was in existence. The species was ready for space.

Then, within a century, the stars were forgotten. Sheer impetus produced a successful voyage to the planet's satellite and an abortive expedition to a neighbor planet. But these failed to fire the species with enthusiasm. As if by premeditation these creatures lowered their eyes and retreated into forests of their own making. Their cities decayed and a rural and parochial culture enveloped the planet.

Why did this species abandon the stars, so alluring to all other beings? What cataclysm chilled their enthusiasm and sent them back to their parklike forests to lie in the shade of trees produced by their own science? Centuries of study have not solved the puzzle.

Kran Author: A Popular History of Irridiclan Spatial Expansion.

The dull sense of unease that had dogged Peter all day deepened as he stepped from the aircar and looked at the Tree. It was a strange growth, startlingly at odds with the normal vegetation surrounding it. From the squat bole, an elliptical cylinder, the major axis of which exceeded its

height of forty feet, to its flat crown of branches, it looked for all the world like a gigantic pineapple. Later, Peter knew, the straight lance of its trunk would bear the evergreen foliage almost two hundred feet above the ground, but until then, years of maturation must intervene. The four years of forced growth was just sufficient to permit the structure to function as designed; beauty and stature must come with time. The pride of possession in a home he himself had planned and built—cell by cell, as he often said jokingly—was now buried under the formless despondence which held him. For a moment he saw only a confused and monstrous mass of vegetation. A line from an old song occurred to him. "Only God can make—"

Hearing Stephanie's buoyant step beside him, he turned.

"As a creator of trees," he said, "Peter Wark is second only to God, but definitely second."

"Nuts," Stephanie defended briefly. "The Tree is wonderful. You're just feeling the tension of tonight's reception in advance. I'm sure it will go marvelously. Besides, we've gone so far we almost don't need their help. We're home, Peter!"

She caught up a blossom from the flowering shrub beside her and poked it into the V of her blouse; caught Peter's hand and pulled him into a reluctant trot as she ran along the road up to the Tree. It was a strange road, for it was formed by a solid, level tangle of roots from the



shrubs on either side and flowering hedges from which Stephanie had plucked the blossom she wore at her breast. And it led to a strange Tree, into which the girl disappeared like a dryad, breaking the fairy performance with the earthy admonition:

"You stay here. I'll get some food."

Presently she reappeared with a pitcher, cups, and a tray of sandwiches. She seated herself on the natural bench grown from the side of the tree.

"Eat, Peter, and drown thy vile humor in this goblet." She poured a cupful of milk.

"Mamma must have told you that

old one about the way to a man's heart."

"Didn't have to. Experience."

A very special pain awoke suddenly in Peter; exploded dully and trailed away. *Yes, Step*, he thought, *you've had plenty of experience, and not all of it with me.* When he looked up, Stephanie was watching him with a little crease in her forehead.

"Peter, what is it? You can't be really concerned about tonight. We have a handful of miracles to dazzle our guests with. It will be a house-warming that will go down in history! And here you are, the major magician, moping like a cat in the cold!"

"I guess I am out of sorts, Step. I suppose there's always a time just before success happens when you wonder: Will it really work? Will it be as wonderful as I've imagined? Or will it be like everything else—different and disappointing?"

"We *are* being profound! What do you mean by 'everything else'? None of it's been easy, but it's all been fun."

"Oh, Step, you know what I mean! From the time I was a boy great things were expected of me. Peter Wark, son of Frank Wark the great biochemist, grandson of Fredrick Wark the great biologist. If I didn't measure up, ghosts would turn in their sheets. If I did rather well, what of it—I was a Wark, wasn't I? Let's not dawdle, my boy. Get on with it. Excelsior!"

"But you've done marvelously!"
"But the successes somehow didn't signify. In some vague way they weren't mine. When I discovered the organizer principles of plants, it wasn't an elegant piece of research by Dr. Peter Wark. No! It was work done by that Wark fellow. You know! The son of the biologist Wark? All the ghosts got an extra sheet!"

"Peter, you run yourself down too much! This wonderful idea of yours for a new, more natural way of living for everyone—our Tree—that's not papa's idea or grandfather's. And me, Peter. There are no ghosts between us."

Aren't there, Stephanie! When have I possessed you completely?

When you didn't take off for a pleasant interlude with Sam Cresson or Carl Fitch or some other interesting fellow.

The special pain welled up in Peter. He looked away for a moment.

"You know, Step, I've got a rather special idea. Now we're finally at home in our Tree why not do it up brown by getting married?"

Stephanie sat back with her head resting on the trunk of the tree, her face tilted upward toward the sky: After a long while she spoke.

"Married, Peter? You mean tied up together by a ceremony as if we didn't trust each other without one; legally become each other's property instead of coming to each other out of our own need and desire? Why, Peter? Especially since people don't, any more."

"Some do still."

"For reasons that have nothing to do with real marriage. Because a woman wants to be sure of support, perhaps; or because a man is so doubtful of his own value that he needs legal guarantees. Or perhaps because either is so grasping that he or she demands everything from the other, including freedom. Only economic need and social pressure used to maintain marriages, and now that living is easier and prejudices looser, the institution is dying. And Peter, we are married! Not as people used to be, but as almost everyone is now. We have been held together by our interests and our work and because

we love each other."

The pain was still there, throbbing a minor harmony to Stephanie's soft voice.

"I suppose, Step, that a man needs some one thing all to himself. Something that is always there and is never in doubt."

Stephanie sat up and smiled. "Your Tree, Peter. It will always be here. It's unique and marvelous and it's yours by right of creation."

"Ours, Step."

"Your very own, really. You discovered most of the knowledge that went into it; you planted it; you shaped it into a home. I just went along for the ride. I've been lucky to have had the chance to help with something as important as this. At first — perhaps you guessed — I thought it was a cute, crazy idea, to get people to live in trees again! But now I'm convinced that it's possible to have homes for almost nothing, and better homes than any amount of money could buy. Who could have dreamed it? Air conditioning without power; furniture grown in place; no well, no plumbing, but plenty of water and sterile at that. Even self-renewing rugs! And all for a hundred dollars' worth of chemicals!"

"There's more to it than that, Step. People need more than just a place to live. They need to be relieved from that eternal worry of just getting along, just making ends meet; and if they miss once, not being able to catch up. That's the reason our progressive industrial so-

ciety manufactures as many neurotics as it does gadgets; that and the fact that no one owns anything or belongs any place. You know, if you and I suddenly found ourselves dead broke—no jobs, no visible means of support—we could still live in style here with our Tree and our acre. We'd even be people of property. Peter Wark and Stephanie Hall, of Bramble Acre!"

Stephanie smiled, to see Peter throwing off his despondent mood as he always did when he really got going on his idea. As he spoke, the inhibitions of his characteristically introverted personality melted away, and his reserve gave way to animation and determination. She felt a throb of pure affection for him. Her own impressionable personality was always subject to seduction by the strength or intensity of others and often by sheer novelty. She knew that she hurt Peter often, and as often resolved to be more generous and gentle, but she had never discovered any method whereby she could become other than herself. She had waited until now for fear of causing him another hurt, but the subject had to be brought up. There was one more guest coming that night. Without preliminaries, she said:

"I received a letter from Sam . . . Sam Cresson; asking to come to the housewarming. I wrote telling him he might." And as Peter sat stunned, she continued:

"In the first place, I wanted to give us the satisfaction of showing

him how wrong he was. In the second, I've never been able to satisfy myself about what he did at the Harvey Lecture. I wish I had been there that night. I've always thought of him as being a different sort of person."

Something painful in Peter shaped the retort:

"Surely you should know, Stephanie. You spent all of one pleasant summer with him. But as far as I'm concerned, I've stopped wondering about the mystery of the great Sam Cresson. He denounced me at the lecture simply because he had his own prestige to maintain. He sponsored me, and when the audience reacted to the 'fantastic' things I said about people living in trees turned out to be unfavorable, he simply got out from under. I'll never forget his little speech at the end. 'Fellow scientists: No one regrets more than myself the painful exhibition we have just had the misfortune to witness. When I asked Dr. Wark to deliver the fourth of this series of lectures, I, of course, presumed that he would speak upon the fundamentals of plant biochemistry. That he would choose to submit us to this fanastic farrago of pseudoscience crackpot economics and bad art, I could not imagine. I apologize to this distinguished audience.' And then he walked off the rostrum."

"It seems to me that what he said was much stronger than it had to be, just to excuse his having sponsored you for the lecture. Besides, he knew in advance, didn't he, what

you were going to say?"

"I suppose I did go beyond what he might have expected. You know what the Harvey Lectures are like. The speakers are not expected to stick to actual bones, but to explore the implications of their subjects with regard to related fields. Well, I drifted into the possibility of universal biochemical housing and discussed the changes such a development would cause in our economic structure—the decline of cities, shrinkage of the structural and metallurgical industries, and so forth."

"What did he mean about bad art."

"I guess I should have known better than to speak of art to a technical audience, but you know how I am when I get going. I pointed out that modern artistic schools like expressionism, cubism, dada-ism and the like were the products of displaced souls who were, suffering from the lack of reliable points of reference and who projected their private conflicts into their works. I intimated that in a society where each man had a permanent place to live and a degree of self-sufficiency, we could expect a type of art that was more comprehensible and more conservative."

Stephanie was silent, thinking; but the key escaped her. Not for the first time she examined the picture she carried in her mind of the Sam Cresson she knew. Her impression was that of a tolerant, enthusiastic,

and above all, intelligent personality. Could Peter's discussion of economics and art at a scientific meeting have so offended Sam's sense of fitness as to call forth that vindictive denunciation? But Sam's own radical views on the possibility of interplanetary travel, and its social and economic implications, were at least as unorthodox. What then could have induced him to turn and stab Peter, whom he had so long helped and encouraged, and by whom he was so much admired?

Perhaps her own behavior had embittered the relations between the two men? The possibility was one that she had always put from her mind, although she knew that Peter considered it bitterly. Facing it squarely, she was forced to decide, not without reluctance, that here also the solution was lacking. She knew frankly that she had never been of sufficient interest to Sam to move him to violence against a friend. She had pursued him literally without shame, her interest aroused as much by Sam's indifference as by Peter's admiration of him. Perhaps perversely—she knew herself well enough to make the charge—she had thought to test her powers against the friendship of the two men. In any case, nothing was decided. Sam had accepted her easily, as was common in the present social scheme of things, his willingness encouraged by Peter's proud pretended indifference. And he accepted the close of the interlude as easily; an interlude unsatisfactory to her because it

contained nothing of that element of conflict of personality which she craved unconsciously.

No, she thought, not for her sake had Sam launched his tirade. Perhaps tonight he himself would explain. She produced the letter and gave it to Peter.

Dear Stephanie,

I understand that you are giving a reception to a number of influential people to demonstrate the charms of your new home and incidentally to enlist the support of your carefully selected guests in Peter's "back to nature" drive. I realize that Peter has excellent reasons to detest me, but after being a confidant for so many years to his ideas and dreams, I would very much like to be present at their realization. I promise to make no effort to destroy your plans, and if Peter will see me, perhaps I can make clear certain reasons for my actions which will redeem his opinion of me.

Sincerely,

Sam

Peter read it through twice.

"Let him come, since he promises to be quiet. Let him see the results of the pseudoscience he thought so fantastic. As far as my opinion of him is concerned, there's precious little he can say or do to change it. But Sam deserves to be here tonight, if only for old time's sake."

Peter's last words were muffled. Stephanie's arms were about him and his face pressed tight against her. She rocked him gently.

"Don't be too sure, Peter, of what you will think. People are complicated creatures, and the reasons that will make one person do one thing,

will make another do the opposite. We are all both worse and better than others think us to be."

They remained so for a while. Then they arose and went into their Tree.

At seven the guests began to arrive. Norman Cain, the handsome and dynamic owner of the Cain Construction Company, was the first to appear. With him was his engineering supervisor, Nelson Huber. Peter, busy with the chef's salad, his usual sole contribution to the bill of fare when Stephanie and he entertained, interrupted himself in the midst of his composition to manipulate the various pale liquids, which when combined, would become a number of daiquiries. He smiled to himself as the two men surrendered their shoes and socks on Stephanie's stern instructions. The footwear would not actually damage the fine matted tangle of adventitious rootlets which formed the carpets for all the rooms except the kitchen, but Stephanie had devised this stratagem to overcome the first reserve of a gathering of near-strangers.

"After all," she had pointed out, "it's the psychology of the thing. Not only will it give us a topic for conversation right away, but it'll squelch the critical attitudes they're bound to bring with them. A fellow can't really feel superior in his bare feet, if only because he's an inch shorter than he's used to. Also it should engender that happy family feeling."

Peter brought the drinks into the living room, interrupting Stephanie's little lecture in being domestic in a tree.

"You'd leave your overshoes in the entry when you came out of the rain into an ordinary house. Here you take off your shoes and squiggle your toes in the rug," she said, demonstrating. "A highly superior method from the digital point of view. I predict that as more people become tree-dwellers, shoes will be made more sheddable."

"Drinks, gentlemen," offered Peter.

Cain and Huber arose as Peter handed about the frosted glasses.

"I've had the pleasure of hearing some of your popular talks," said Cain. "I'm glad of the chance to see the thing itself."

The bell sounded three tuneful notes and Stephanie admitted Charles Hearn of Fermentation Industries, who was forthwith rendered barefooted while Cain and Huber grinned. The comic interlude was repeated with Richard Wilson and Harry Foxx; Domestic Appliance Corporation and National Air-car Company respectively.

Stephanie joked and chattered, but Peter remained self-conscious and withdrawn—waiting. He answered the door himself when the bell announced the final visitor. Sam was one of those timeless beings whose appearance defied the erosion of years, but to Peter he seemed almost unrecognizable. Five years of resentment had created in his mind

a fictitious and unflattering counterpart.

"Hello, Peter. May I come in?"

Peter, torn and speechless, fell back on Stephanie's blessed device—pointing at Sam's feet and the row of abandoned footwear in turn. Then Stephanie took charge of the introductions while Peter escaped to mix more drinks. He returned, gave Sam a glass, then sat down and nursed his own. Stephanie meanwhile had guided the conversation in the desired direction of the Tree.

It was Cain speaking: "You know, this place looks like any other. A little odd and arty, maybe, but I've been in plenty queerer." He threw a smile at Stephanie. "Though in none with a hostess as charming."

Peter caught the near-invisible gesture about Stephanie's mouth that meant pleasure, and wondered again at her immense susceptibility to flattery. He was suddenly glad that for Cain, at least, he had the proper ammunition.

"Apart from the things you don't see, Mr. Cain, there's a difference you'll appreciate. The place, as it stands, cost a thousand dollars, and almost all of that for the land and furniture. Just the house came to one hundred and ten."

The incredulous shock in Cain's face was a delight to Peter. Huber stepped in:

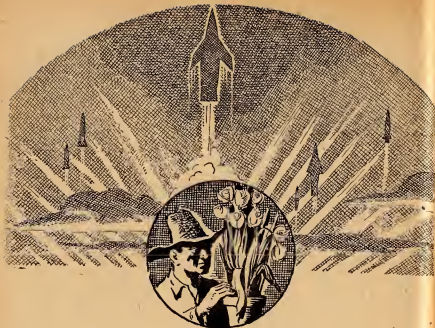
"Three or four years of your time would make it worth rather more than that."

"No, you're wrong. I'll explain

later. Right now we might as well get down to business. You were invited here tonight to form a new organization. Suppose I let Stephanie take over to start with; I'll come in on the technical discussion." He looked at Stephanie, who collected herself and began:

"Together, you people represent four companies, each one of which has a positive interest in this house and in others like it. I except Reaction Automotive, whose president, Mr. Cresson, is here only to observe.

"I'm speaking on the assumption that houses like this one offer final and unbeatable competition to the conventional private dwelling, both as regards cost and quality. I think Peter will convince you of that in a moment, but just now let's assume it's true. In that case the Cain Construction Company"—she smiled at Norman Cain—"will construct no more houses if it does not help with these. Domestic Appliances will put out a new and profitable line, especially if it is first in the field. You understand, Mr. Wilson, that tree-living requires furniture to match. And Mr. Foxx will sell a lot more air-cars when people leave the cities and swarm into the woods. I believe that the greatest percentage of air-cars are sold to suburbanites. What we propose to do will turn practically the entire country into a vast suburbia. Fermentation Industries supplies practically all of the vitamins, plant hormones and biologicals that are needed to grow these houses; at least so Peter tells me. So Mr. Hearn



also has a special interest in this development.

"For me, helping to grow this Tree of ours has been a wonderful project, but to Peter it has meant a great deal more. For one thing, this research has been his life's work. More than that, Peter believes, and I've come to agree with him, that this represents an answer to one of the great problems of modern society, which is troubled by the lack of economic, social, and spiritual security. However that may be, Peter is interested in getting the thing started as soon as possible. That requires funds to buy land, and a much smaller amount for chemicals. And that, gentlemen, is where you come

in. I might point out that you have no choice. We could and would carry out the job without you and we have potential funds to do it with, but it would go more slowly than we wish.

"I've noticed that all of you have been doing a bit of glancing about since you came, and, as Norm remarked, have seen nothing too unusual. Our assets, like those of the Bank of England, are mainly out of sight, or at least camouflaged.

"Now I'll go and produce some food while Peter explains the hidden magic."

She looked at Peter for his smile of applause, smiled herself, and disappeared. Peter began on cue.

"Gentlemen, this little talk isn't new." He spoke at Sam. "It was made once before, at one of the Garvey Lectures five years ago. Now, though," he looked about the room, over the heads of the listening men, "I have the advantage of superior surroundings.

"Before I go into the mechanics of the Tree, I'd like to call your attention to some details which I'm sure you haven't noticed. I said that this place cost a thousand dollars; one hundred for supplies and almost all the rest for the land. It may have occurred to you that very little is left for all the furniture you see here. Suppose you examine it now."

Wilson and Foxx became interested in the wall lamp that extended out between their two chairs. Charles Hearn squiggled his toes more vigorously in the rug than he had when Stephanie had introduced him to it. Cain traced down the feet of his chair until they became integral with the floor. Nelson Huber was an amateur woodworker and had been fascinated by the end table to his left all evening. He gave his undivided attention to it now.

They all made discoveries.

Only Sam smiled and remained still. When the others looked up with dawning comprehension, he said:

"Obviously, Peter, if the tissues of a plant can be made plastic enough to assume the functions of a house, it wouldn't be too much to torment a little furniture from it, too."

"Observant as ever, Sam. Have

you noticed anything else?

"The bookshelves have been grown out from the walls, also. The finish on the walls is natural. Even the cocktail table, which is movable, resembles the rest so closely, that I should imagine that it was grown in place and then detached. In fact, I should suppose that all of the fixed installations and most of the movable ones, are a by-product of the Tree."

"Quite right. Every piece of furniture that can dispense with metal or which does not require moving parts, has been grown along with the Tree. The discovery of the organizer principles of plants, which began with the work on plant hormones, actually permits us to regard a plant almost as a plastic structure. If due regard is paid to the physiological needs of the organism, water, minerals, carbon dioxide and energy, the actual shape of the structure can take almost any planned form one would wish.

"Living in a tree isn't as cute and crazy as Stephanie once thought." This, fondly, as Stephanie reappeared with food and oddments. "The biological mechanisms of a tree lend themselves to the purpose. For instance, although it seems not to have been noticed, the house is air-conditioned."

He got a marked surprised reaction from the intent circle. Richard Wilson, whose firm did a huge and profitable business in home air-conditioning equipment, voiced a protest.

"That must take at least some

machinery!"

"So it does, Mr. Wilson, but not the kind sold by Domestic Appliances. The machinery used here comes with the Tree, and is definitely cheaper and more efficient."

"I can imagine that in some way you use the cooling effect of evaporation from the leaf," interjected Sam, "but how do you control the humidity? I've been wondering about that ever since I noticed that this house—tree—is virtually hermetically sealed."

"You've got your toes in the humidity regulator," Stephanie giggled.

"Yes," said Peter. "The carpets here are a mass of adventitious rootlets. The main function of roots, as you know, is to absorb water for the use of the tree. These function whenever the relative humidity exceeds about forty-five per cent. The climate is mild and dry."

Turning to the other: "Mr. Cresson spoke of the cooling effect of evaporation. As you know, a tree absorbs from the soil and evaporates from its leaves a tremendous amount of water each day. In this one, which is designed to have an immensely extensive root and foliage system at maturity, the amount of water transported is astonishing. The evaporation of this bulk of water serves to cool the leaf. At the same time the leaf admits air by diffusion and the carbon dioxide in this air serves for photosynthesis. The by-product oxygen normally diffuses out of the leaf again. This

Tree, however, has been provided with a circulation system, so that the oxygen, cooled in the leaf by evaporation in a sort of heat-exchange process, is led into the interior of the tree. This results in a perceptibly higher oxygen concentration inside the Tree. We have noticed a curious consequence of this: The ideal temperature and humidity that prevails inside the Tree, together with the feeling of well-being due to the higher oxygen content, causes a psychological reluctance to leave after a period of time."

Peter paused, aware of Sam's sharp glance. Wilson broke in:

"Do you mean that all the oxygen that we are now breathing is supplied by the Tree?"

"No. A much greater amount of unaltered air, cooled in the same way enters the tree by the same route. Incidentally, the fact that a tree naturally handles such a large amount of water, enables us to divert a small part for our own use. This disposes of the need for a well and pumping machinery."

Wilson groaned. Pumps for the purpose were also sold by Domestic Appliances.

"During the winter, no leaves, no air. What then?" This from Hearn.

"This is an evergreen, Mr. Hearn. The leaves, which admit air, remain. Water transport is at a minimum, but the cooling effect is not so greatly needed then."

"How about heating?"

"That's no problem. The Tree is

hermetically sealed, except for the matter of air supply. Heat is supplied by our bodies, and our appliances for cooking, refrigeration and so on. Also the biochemical processes of the Tree itself release heat, so that in a sense our Tree is warm-blooded. The air enters through the sun-warmed leaves which form a warm-air solar heating unit far more efficient than that of a glass-walled house; therefore, there is usually a positive heat balance to be taken care of by transpiration. The process is controlled by the fact that any increase in temperature results in an increase in metabolic activity and water transport. In this way, the temperature is self-regulated."

"What about heat for cooking, bathing and so on?" Wilson was having an unpleasant vision of Domesticity sans Appliances.

"There you have us Mr. Hearn. Our Tree cannot give us heat at high potential. We get our power from a small electric generator that runs on oil. I can foresee modifications that would supply the fuel, such as having the Tree yield an oil-bearing nut; or planting an oil-bearing seed crop on our acre. But the generator appears necessary. In our projected development, it would probably represent your company's staple product, along with the conventional electric oven, refrigerator, toaster and so forth."

"I presume that a continuing need for nutrient chemicals will exist as long as the Tree is in use?" Hearn asked.

"As a matter of fact, no. Nutrients, vitamins and plant hormones are required to shape and force the structure at first. When the Tree is adequate for occupation, it's structure is set. The only remaining need, except during periods of remodeling, which can be done, is that for nitrogenous nutrients. This requirement is fully met by the waste products of the occupants. All wastes are led to a small excavation some distance away, to which a portion of the root system has been diverted. This arrangement replaces the ordinary septic tank and provides for the nutrition of the Tree. Incidentally, conventional plumbing is replaced by large, fast-growing roots, the central cores of which disappear on maturation, leaving hollow ducts. By proper application of tissue-organizing hormones, such roots can be made to grow throughout the tissues of the Tree itself. To speak more accurately, proliferating embryonic tissue can be made to assume the functions of roots at specific locations."

"In a very real sense, then," said Sam, "the Tree is in a strict symbiotic relationship with the occupants."

Peter nodded. "The Tree also benefits from the carbon dioxide supplied to it by its occupants. That is one reason it can be occupied so early. It benefits by inhabitation. Right now this is really a two-person Tree. In a few years, the root and leaf system will be adequate for six."

"Dr. Wark," said Foxx, "for myself and Mr. Hearn, this project you speak of seems, if successful, to give promise of increased markets and profits. But for Mr. Wilson's company and that of Mr. Cain, a sad contraction in business would seem to be in prospect."

"On the contrary. If you people get in, so to speak, on the ground floor, you will be more active than ever. Mr. Hearn, I fear, will supply no air-conditioning apparatus, but he will have an unlimited market for generators, refrigerators and electric stoves. His business, although minus many present items, is bound to increase with the vast general increase in housing. Mr. Cain is in another category. His construction company will acquire a pronounced biological tinge. He has no choice, however, since his product is from this date, unwanted. However, apart from the products your concerns now manufacture, it is obvious that such an organization as I am proposing will have vast opportunities. Since I myself control the basic patents in the field, our advantage will amount to a monopoly. This monopoly, as I conceive it, will be a benevolent one. My only interest is to speed the new development and towards this end I shall, of course, exercise major control of the company to be formed. I require the funds that you people can provide and I shall undertake to admit profits in proportion. It is my impression that a selling price of fifteen hundred dollars per Tree,

land and furnishings included, will permit a profit of one third, or five hundred dollars. At a minimum estimated market of thirty million houses, that comes to fifteen billion. I would say that a bright financial future is in store for us."

A pregnant pause ensued while each of Peter's guests waited for the other to speak. Norman Cain broke the silence:

"Dr. Wark, perhaps I might be excused for speaking first, but it seems that my company will be primarily affected. You suggest . . . what were your words? . . . 'that the product I produce will be from this date unwanted.' Now on the basis of your very persuasive talk and on the evidence of your very wonderful house which I admit may be all you say it is—"

"If it were not, Mr. Cain, my proposals would have as little point for me as for you. Moreover, there are patents covering all of this which you may examine."

"Well then, granting all of it, still this Tree took years to produce. It is untested in actual use except by yourself, and you are uniquely qualified to deal with any difficulties that can arise. Your time, over the past years must, as Mr. Huber pointed out, be reckoned as part of the cost. I presume you expect that factor to disappear in quantity production. It may be so, but at present we have one man and one Tree that took years to grow."

"You are quick to assume, Mr.

Cain. I contradicted Mr. Huber on this question of time earlier. Stephanie has told you that we would proceed without you if necessary, for we do ourselves have potential funds. I will tell you now that during the past four years, we have produced not only this one, but an even hundred of these Trees, and could have produced many more if our funds for land and supplies had been greater. This work has cost us one hundred thousand dollars, almost all of which was advanced by prospective tenants. You will agree, I think, that my time for four years divided by one hundred would not come to very much. To go on; all of these homes have been tenanted for more than a year, so that the project is not exactly untested. Finally, let me ask you for a cost estimate of our home, Mr. Cain."

"It cannot be reproduced at any price. I could find any number of buyers at forty thousand."

"They would go rather higher than that, I fancy—air conditioning, furniture and landscaping. The last is also biochemical. You may have noticed the road as you came up. Be that as it may, we have contracts with the present tenants which permit sale at twenty thousand at our option. That comes on two million, quite enough to go ahead slowly on our own. But I don't want to sell a few thousand houses at twenty thousand. I want to produce several million at fifteen hundred. It is for this reason that you are given this opportunity."

"Gentlemen," Stephanie broke in, "I notice that argument has interferred with appetite. Half my sandwiches are uneaten."

"I should like to see these houses," persisted Cain.

"You will, gentlemen," said Stephanie. "Tomorrow, if you like, I will personally conduct a tour to our properties—to all one hundred of them if Mr. Cain insists. We even have four vacant Trees to bestow—one per company. Why don't you think it over tonight and meet me in town at the Stadler tomorrow for an arboreal expedition? I'm sure you'll find it most convincing. You can give us your answer afterward."

There was general agreement at this; each of the guests was presumably thankful for an opportunity to digest his dose. After the usual excuses, they left. Sam remained.

"What do you think, Sam," Stephanie asked, "will they do it?"

"They will accept, of course. The situation is as you say it is. They have no choice."

From Peter: "Cain sounded rather unpleasant."

"I didn't think so," defended Stephanie. "He seemed very interesting—rather good-looking, too. Those questions were bound to be asked and quite logically he asked them, since he was most affected."

"What do you think of my 'fantastic farrago of pseudoscience?' Those were your words at the Garvey Lecture, I believe."

"Peter, I'm sorry for what I said

then. It's not what I believed and not what I should have said. There was a reason for my saying it, though; a reason which is confirmed, by what I have seen here tonight. Perhaps when you know the reason you may not condemn me."

"What is it then?"

"I came here tonight to tell you but I'm afraid that now, on the night of your triumph and inside the miracle you've created, I could hardly make it clear. I've come tonight to see your work; could you come tomorrow to see mine? Much has happened in the five years since we last met. I have something to show you, too. Let me guide you around Reaction Automotive. It may be that there I can get across what I want to say."

"Why don't you, Peter," urged Stephanie as he remained silent. "I'll be out all day with our future partners. You can drop me in town and go on to Reaction Automotive Center. I'll pick up some food and guarantee to beat you home and have dinner waiting."

Peter wanted to refuse. He nodded.

Reaction Automotive Center was a vast development of factories and proving grounds. It had its beginnings in the commercial ventures of Robert Cresson, but the present mushroom growth of the enterprise was due to the genius of his son. Robert Cresson made his fortune in aircraft construction during the second world war. He made it in spite

of a noticeable lack of business acumen, proving that Virtue does occasionally bestow rewards. Detesting the twin evils of Nazism and Fascism, he liquidated his modest business in men's clothing and used the proceeds in a private war of his own against totalitarianism. At that time the Axis Alliance was engaged in crushing nation after nation into slavery with the prime weapon of air power, so Robert poured all his funds into the manufacture of aircraft. The venture failed miserably in its first year, and Robert's more clever associates bailed out, leaving him with a mountain of debt and a bankrupt airplane factory. When the United States entered the war, however, the government, avid for planes, refinanced the venture, which expanded geometrically during the war years. Afterward, when other aircraft companies failed or converted, Virtue continued to favor Robert with fortune. During the profitable years he had made his factory a haven for refugees and displaced persons. Among these were the foremost European proponents of rocket propulsion, and under their influence Cresson Aircraft pioneered jet and rocket-driven aircraft as well as guided missile research. In the uneasy time of the cold war these products were in demand.

Sam grew up with reaction propulsion. He grew up also with men who thought long thoughts of the far stars. For these men whose rockets mangled the earth had laid the

foundations of their science, not on earth, but in space. The first rockets they built veered or exploded, but they were pointed at the stars. Sam was weaned on the milky way.

In college Sam met Peter. He was several years Peter's senior and was already recognized for his brilliant graduate studies in atomic kinetics when Peter, awkward and alone, first began the studies which were to lead him to his discoveries in plant biochemistry. Peter was thought "queer" by his fellow students, but his sweeping theories regarding the possibility of altering botanical structure and creating more useful species through a deeper understanding of hormonal effects attracted Sam, himself sprung from the desperate traditions of a science that had plotted the cold curves of celestial navigation at a time when no fuel was available that could lift its own weight out of the Earth's gravitational field. He taught Peter an old statement, precious among the early rocketeers: "If a thing is desirable and not theoretically impossible, the odds are infinitely great that it will be done."

Sam's friendship and approval meant a great deal to Peter, whose upbringing in the shadow of the previous great Wark reputations had instilled in him an unhappy tendency towards self-criticism. When Sam left the University to manage and transform his father's business Peter sank again into despondency and self-doubt. It was his discovery by

Stephanie that made him bloom. She took up with the strange shy boy, attracted by his differentness, and gave Peter a sense of importance and of being desired. Peter, in the intoxication of his first love affair, cast off the deadening drag of his own self-criticism and in this period, during which he did his graduate work, he went beyond the early knowledge of plant hormones and proved that the entire development of plant structure was mediated by a host of biocatalysts to which he gave the name of "organizer principles." Meanwhile, subtly, his objectives changed. With the unconscious wisdom of love, Peter modified his projects to include Stephanie, and the idea of the Tree was born.

The Tree fulfilled an unsuspected need of Stephanie's—one neither of them knew existed. In the rootless and promiscuous society of the time most people drifted easily in and out of relationships, vaguely seeking realizations which they had not the tenacity to achieve, and Stephanie was by no means innocent when she met Peter. The idea of the Tree, which came to be her project as well as Peter's satisfied this need for dedication in her, so that the union became a permanent one, only occasionally interrupted by the small infidelities which were demanded by her personality. The most serious of these was the brief interlude with Sam which resulted in little satisfaction to her and a great deal of

damage to Peter, who became more withdrawn than ever before in their relationship.

This history painfully occupied Peter's mind on the long walk from the main gate to the Administration Building of Reaction Automotive Center. He had refused the limousine at the gate so as to examine the grounds more thoroughly on the way to his appointment. What he saw was a vast apparatus for rocket research, for Sam's dedication to Space had transformed the old Cresson Aircraft Company to the virtual exclusion of any other means of propulsion. The factories were busy with all applications of rocketry from toys to strataliners, and from the proving grounds, man-made comets continually ascended. The Center included a skyscraper group in which the personnel of the Center lived and played. It also housed a new university which offered the most advanced studies in the physical sciences and in astronomy. The whole represented certain ideas of Sam's as to the desirability of mental contact and stimulation for the conduct of successful research. Peter, who had spent the past few years with his trees and infrequently visited cities, found all this activity confusing.

At the Administration Building he gave his name to the reception clerk. A moment later Sam appeared to greet him.

"Hello, Peter. What do you think of it?"

"It's grown a great deal since I saw it last, but I'm too much of a rustic to appreciate it. I'm more at home with my Trees."

Sam gave him a shrewd glance. "Let me show you around. We'll see if we can't make some sense of it." He drew Peter into a waiting convertible—top down for observation. They were driven about the Center, Sam explaining the functions of each structure.

"Here," indicating an enormous, low, glass-walled building, "we make the rocket motors for the transoceanic strataliners. Over there in that brown brick affair we manufacture rocket toys. Give us time and we'll have the kids playing with rockets in the crib. That white tile building in the distance produces guided missiles." Sam's voice droned on.

There appeared to be more practical applications for rocket propulsion than Peter ever dreamed of. And as the lecture continued, his spirits sank. Deep down there was something in him that remembered and admired the friend of his school days. This extroverted executive was a disappointment to that memory. He forced himself to speak:

"You seem to have come back to earth at last. I never thought you'd be satisfied with anything but open ether."

"The highest branch must have roots somewhere to supply the nour-



ishment. Let's go to the proving grounds. We've just put in a new line of meteorological rockets that are a little closer to it. They're due to be fired today."

At the proving grounds Peter witnessed a display firing of high altitude rockets. These were two- and three-step affairs, the detached portions laden with instruments came down on silken sails while the last step disappeared in the sky. Through a powerful telescope Peter watched it explode at the height of its ascent.

"They're tracking them on radar," Sam informed him. "The three-step affairs can go over three hundred miles high."

"Is that the space conqueror?"

Sam replied slowly. "No, Peter. I've given up hope with conventional fuels. Those things keep the designers' hands in. I don't say that at enormous expense it wouldn't be possible to design a multi-step rocket that could approach a planet, though the factor of safety would certainly be small. But space can't be conquered by stunts! The space conqueror, or rather the first hope of it is over there. We'll visit it next."

The convertible dropped them at an oblong concrete block of huge dimensions. Peter was led into a conference room and motioned into a chair. There was nothing to be seen.

The room darkened; one wall

glowed. On the television screen two squat conic sections approached one another, blunt points foremost. There was a ravening outburst of white fire. The lights went on.

"Do you understand?"

"Is that going on in this building?"

"Yes. Fast fission. They played with it decades ago and we haven't tamed it yet. We're still stuck on problems of shielding, by-product poisoning and control. And the integration of the effect for drive function is in its first stages. But we have ideas. Given time we can do it."

Sam became silent. Vague intuitions played in Peter's mind.

"You've taken our time away, Peter."

Peter sat, waiting.

"It's odd, isn't it, that long ago as each of us followed our own studies and encouraged the other, neither knew that our goals were contradictory. If that thing in there were tamed, your Tree would never grow. And now the Trees will shut out the stars."

"I don't see that."

Sam continued as if he had not heard. "It came to me clearly at the Garvey Lecture. I called you a fool and a fraud, Peter, because you see, I, possibly I alone, believed you."

Emotion exploded in Peter—justification, satisfaction, release. Victory over some portion of his personality that criticized and denied. "I believed you." Something cold and bitter inside him melted.

"But then why—"

"You said enough then to convince me that your final success was certain. But there was more. You discussed the social and economic implications of your biochemical housing project. Then, at last, I saw."

"What did you see that could interfere with your work?"

"I saw a planet suburbanized and largely de-industrialized. I saw the ascendancy of biochemistry and the neglect of physics. More important, than these I saw the elaboration of a parochial social ethic attached to the soil beyond all uprooting. Space will never be conquered by yokels!"

"Listen, Sam, aren't you going overboard?"

"No, Peter. As I say, I saw all this in a single revelation. But since then I've been documenting. I've had an entire group working on the consequences of your project. What will the effects be on consumption and production? On the steel industry? On light metal manufacture? On atomic power? There is only one answer: A society as extensively ruralized as yours must be, lacks the industrial network that must be the basis of space travel. I've had the project gone over by anthropologists as well. Their judgment is the same. Your success is inevitable but it will also be final. We will pay the price of all symbionts that adapt themselves too well to their environment. That price is the inability to leave it."

"Men will always yearn for the stars and work to attain them."

"Who has yearned for them in the past? A handful of crackpots, mocked by the good folk who tended their fields and cultivated their gardens! Who will want them when each has his Tree and his acre? No one! Actually you know this, Peter. From another point of view it's what you've been saying when you talk about giving people emotional and economic security. If these are satisfied at home, who will look for them in the sky? No one will be sensitive to unorthodox ideas in a static, rural society. It is only the rare, dissatisfied soul who is so now."

"Granting all you say, it may be the stars would be well lost in exchange for happiness."

"Happiness? Only security."

"They are the same."

"I know you think so. It has been the tragedy of your life. As an heir of the famous Warks, you have unconsciously developed a standard of achievement that now you can never meet. You mistrust all your abilities and value security so highly because you have none within yourself. You look for it in things and people. I provided it in college. Now there's Stephanie and your Tree."

Peter was moved to protest, but remembered something of his conversation with Stephanie the day before and said nothing.

"I said what I did at the Garvey Lecture believing that if you thought I had lost faith in you, you would be

overwhelmed by your usual self-criticism and give up. But there has been Stephanie to support you."

Hot anger flashed through Peter. "You thought that and were willing to sacrifice me so easily!"

"I would sacrifice myself for what is involved. You know I speak frankly."

Peter subsided. He knew Sam spoke the truth.

"At any rate, the die is cast. I could hardly stop it now. Even if I called off the organization we planned last night there are still a hundred Trees in existence and tenanted. And my patent applications are on file."

"I think you could stop it if you would. The Trees could be destroyed; poisoned or made functionless. No one besides yourself could judge the cause; they would merely be considered failures. And the applications could be withdrawn."

Peter spoke with an effort. "Sabotage the Trees?"

"Man stands at a crossroads. You can bind him to the planet; Peter, or you can free him for the stars. You can fulfill for him your own vast desire for security or set him on the infinite adventure. It may never before have happened that an individual, clearly foreseeing the consequences, possessed the power to choose the history of his species. That is your choice now."

"If I agree and choose space, then I must destroy all my work. More, I must give up the studies

I've spent my life preparing for. That's a sorry prospect for me!"

"Do you think that the conquest of space has no place for biochemistry? Think of Venus. Only plants can split the carbon dioxide in her atmosphere and supply oxygen for Man. No one could better design the flora of Venus than you could. The full conquest of space implies the taming of the atom, but even with an unmanned step rocket we could approach Venus to disperse the seeds and spores you could design to alter her atmosphere."

"That would take centuries!"

"What of it? We could start today! Isn't it a better job to prepare Man's new home than to furnish his retreat?"

Peter was silent, exhausted with conflicting emotions. Finally he said:

"Let me think about it a while. I'll get in touch with you again."

Peter set the aircar down in a little clearing near the Tree. It was later than he had expected to return and it was quite dark but he saw no light showing at the entrance to the Tree. He went in and found the place empty. Stephanie had not yet returned then, thought Peter, with a feeling of relief. He wanted time alone to think of the day's revelations. He went out of the house and walked about, an unfamiliar sense of peace pervading him. It was a cool, cloudless summer night; the sky was a bowl of spilled milk and

the moon a silver disk you could climb up to on a ladder. *Why not?* thought Peter. *I'll do it! What's up there is too good to be hidden away by leaves!* He looked for Venus in the evening sky and wondered if an earthly flora would turn her green. The cool air seemed like wine to him and he became consumed with a mounting exhilaration. It came to him that he was making the most appropriate answer to the Wark ghosts. He had painfully tracked in their footsteps; had even exceeded them in their field and now, calmly, he would put aside his imminent triumph as not good enough. He hoped ghosts could notice.

Suddenly he became eager to tell Stephanie about it. The Wark ghosts were dead, but Stephanie would understand and appreciate. Where was the girl anyhow? She was to have had dinner ready when he came. She would probably be ravenous herself when she appeared. Peter went back to the Tree to get up some sandwiches. He remembered the larder was practically bare. Stephanie would refill it when she came but, meanwhile, he would try to scare something up.

The refrigerator was overflowing when he opened it. He paused with the starting chill of presentiment. Stephanie had come and gone again. He knew there would be a note.

The bedroom contained the one piece of nonfunctional art in the house. A guardian mascot in the

shape of a rabbit sprang from the living wall. Now it offered him a slip of paper in one paw.

"Thank you," said Peter ironically, accepting it.

Dearest Peter,

They came, they saw, you conquered. They all said yes!

I've replenished the liquor supply and stocked the refrigerator. I'm sorry there wasn't time to get dinner for you.

Please don't be angry or disappointed. Peter, Norman Cain asked me to go back to the Coast with him. I can't explain but somehow he attracts me tremendously. I know it's horrible but I agreed. Be patient with me, darling, and take care of our Tree.

Love,

Your erring
Step

Peter attempted to reread the letter but the words ran together the second time.

He escaped into the night, frantically seeking the peace that had been there a moment ago but he brought his hell with him now. This night too, of all nights, to be destroyed by Stephanie's wanton whims! His mind worked slowly. *Nothing*, he thought, *ever came to him with ease and peace. No achievement was fulfilled, no friend was true. A burst of hatred filled him. That rotten, faithless female!* And Sam also, so eager to destroy him for his own ends! A sudden gust chilled him. Cold and pitiless, the stars looked down. He fled back to his Tree.

THE END

SUCCESS STORY

ASTOUNDING SCIENCE-FICTION



IZZARD AND THE MEMBRANE

BY WALTER M. MILLER, JR.

The computing machine had considerable ability — but there was something besides a computer at work on that haunted machine! And moreover, the whole was greater than the sum of the parts!

Illustrated by Rogers

Scotty MacDonney was one of the Americans trapped in Europe when the sudden and unexpected eruption of uprisings boiled up out of the underground like angry lava. Simultaneously with the local revolutions, the Red Wave began rolling in from the East. But before it reached Paris, Scotty was already

enjoying the tender mercy of the local revolutionaries. They had seized him almost as soon as the first shot was fired. They knew his potential value to their cause. They also knew that "converting" him would be a long and difficult task. But they had plenty of time. Their prophets always promised that time

ASTOUNDING SCIENCE-FICTION

was on their side.

Scotty was a cyberneticist, with incidental degrees in electronic engineering and physiological psychology. He had designed several new and improved calculating machines for American industry. He had invented a synaptic relay for the giant electronic "brain," and it was actually an improvement over a living neuron's all-or-none principle. And he had developed a new method in robot control of guided missiles. His importance to an American war effort was vaguely but not completely realized by the American government.

It was fully understood by the proponents of a new-era.

When the scarlet tide had rushed across the hills and fields of France, Scotty was taken east, to a city where soft snow gathered on strange Byzantine domes whose pointed peaks speared at the chill winter sky; a city where East met West in a subtle transfusion of wisdom and savagery.

Scotty was in his late thirties. He was muscular, but not massive. His face was angular with a kind of handsome ugliness. He was generally calm, patient, easy-going — the practical scientist, with a normal family life. He had married well, and had been thoroughly settled with his wife and two children in an Ohio university town.

He anticipated nervously that when his captors were done with him, he would be gray, broken, and reduced to a warped and schizo-

phrenic shadow of his former self. He even suspected that they would make threats against his family, for it was well-known that there were plenty of agents in America capable of carrying out the threats.

He certainly didn't anticipate what really happened.

He was given an elegant, but well-guarded, suite of rooms in one of the best hotels. He was visited by high dignitaries of their government; they promised that he would not be abused as an enemy alien. Not borscht but caviar, not water but champagne amused his palate. He was offered various kinds of sensual pleasures, but—although idleness was beginning to whet his appetite—he turned them down, thinking of Nora and the children.

Nora, with the pale cloud of hair, with the dreamer's eyes, with the willowy body that could stretch so languorously. He began to think of her so much, so frequently, and so fervently, that he began to carefully taste the strange and exotic foods, examining them for any slight bitter or metallic flavor that might suggest drugs. Nora was constantly in his thoughts; and when a commissar brought his beautiful wife, then was forced to leave by a sudden phone call, Scotty remained restlessly chaste, although the woman had obviously been ordered to entertain him. His captors complimented him for his devotion to family. Their compliments both pleased him and increased his determination to avoid the pitfalls they offered.

IZZARD AND THE MEMBRANE

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They shrugged, smiled with their Oriental eyes, and promised to keep him occupied in other ways. Workmen were sent to tear out a section of wall in each of his rooms. Frosted glass panels were installed in the sections. "Movie screens," they told him, "with projectors behind the walls."

Why behind the walls? he wondered.

Then they covered the screens with heavy, transparent plastic panels. Scotty read a Slavic trademark on one of the panels. It said, "Unbreakable."

Why?

He was stretched out in a soft chair one evening, reading a Russian work on cybernetics, when the loudspeakers crackled slightly. He glanced up. They had turned the amplifiers on. Then, soft recorded music flooded the room, a lovely Russian symphony.

The screen flickered on. The scene was a bedroom—and a sudden chill gripped him. It was his wife's bedroom. From the angle of view, he reasoned that the camera was concealed in a ventilator. There was Nora's purse on the dressing table, her manicure set, her brushes and combs. On the pillows was the familiar giant Teddy bear. Everything was the same.

He stood up and anxiously paced the floor. What were they trying to do? Drive him insane with nostalgia?

Then something moved onto the

screen. He froze in his tracks and stared. *It was Nora!*

She moved to the dressing table and sat down to brush her hair. She used the same long gliding strokes as always. And by the slow moving of her lips, he could tell she was humming a tune. She arranged her hair carefully, then applied make-up. When she was through, she moved to the closet and selected a dress.

It was an evening gown!

Scotty slumped down in the chair again, too weak to stand. He felt more than a trace of bitterness and disappointment. With her husband a prisoner in an enemy nation, with two children to care for, she was wearing evening gowns. He got one last glimpse of her face before she moved out of the room. It was a happy face.

The scene shifted to the hallway. The camera was looking downward and toward the door. Nora appeared, bag in hand, ethereal in the white gown and with a golden chain binding her long ashen hair. The music became romantic. She opened the door. There stood a beautifully tailored tuxedo, with a man inside it. He stepped inside, smiling, and gave her a corsage.

Scotty, stricken though he was, recognized the man. He was a government official, very handsome, and noted for his amatory successes. He had also been investigated by a senatorial committee, but charges of subversion had been dropped.

Nora opened the orchids, laughed

with pleasure, then kissed the man lightly. Then they went out into the evening. The door closed like an exclamation point. The screen went dark.

And for three hours, it stayed as dark as the black depths of Scotty's heart. He shouted curses at his captors, but none answered him.

The music wandered into a classical theme, then into Russian symphony—music of the clenched fist, of sprawling factories, of mechanized peasantry toiling for a cause. Then martial airs—the roar of mighty squadrons over Red Square, ponderous tanks rolling along the streets in full parade—all serious, all determined, all purposive. Then after three hours:

"Woodaddy hoogaddy zoop! My baby's in the soup!"

The sudden savage howl of American jazz. It beat at the eardrums and frayed jangled nerves. The veins in his temples were already pounding with his own inner misery.

The screen became bright again—the same scene, the same closed door. Scotty waited tensely.

The door opened. Nora staggered in, obviously tipsy. The man followed. Then another man. It was a congressman, a friend of Scotty's! His reputation was impeccable. He stood just inside the door, talking to them with occasional laughter. Then he nodded good night, stepped outside.

When he shut the door, it seemed to Scotty that the American gov-

ernment had offered its blessings upon Nora and the other man.

Nora laughed with sudden abandon and began skipping about the hall in a wild dance, like the complete self-release of a marijuana addict. The man was watching with a grin. Suddenly she threw herself upon him, and they clutched at each other in a rocking, wrenching embrace. Scotty could bear no more of it. He clenched his lids together until his eyes ached.

A shift in the music to something low and pulsing made him steal another glance in the hope that the screen was dead. But the act had shifted to the bedroom, and it was one of such utter depravity and horror that Scotty ran out of the room, shouting hoarsely. But in the next room, the same scene confronted him. He threw himself on the floor, closed his eyes, and became violently ill.

For a week the persecution continued. The same picture over and over again, interspersed with Russian newsreels showing troops on the march, factories turning out war planes, high leaders at the conference table. Then the howl of jazz again, and the awful horror. Of course he didn't watch, but it was *there*, and he knew what it *was*, and even with his eyes closed, he could see the flicker of the screen through his lids. And the music told him what was happening. For the week he was left entirely alone. His food was pushed through a slot in the

door. No one answered his shouts.

Then they came and told him that there would be a new set of pictures for the following week—on exactly the same subject. Only this time, they said, he would catch a glimpse of his children's faces as they peered around a doorway and saw their mother.

It was enough. They asked nothing of him. But he told them what he would do for them. He would build them the machine that would win the war. He begged and pleaded with them. They were polite, but reluctant. How did they know he could be trusted? No, he would have to wait until they discussed it with the politburo.

And so, he enjoyed another week of the amusing films.

When he tried to kill himself, they decided that he was ready. In two weeks he had lost twenty pounds. His eyes were bleary and wild. When they let him out of the suite, he fainted with relief. They carried him to a psychologist for indoctrination.

Yes, yes, he believed in all they had to say. Yes, yes, his country was a degenerate imperialist nation. Yes, yes, it was time for the ultimate in revolutions. Yes! Anything! Let him build them something that would do everything from *A* to Izzard.

And that's what he called it: the Izzard.

They gave him to Porshkin, cyberneticist for the cause, a brutal, bearded man, who treated him to

rough threats and verbal abuse, who criticized his scientific theories according to political dogma. But Scotty moved as through a daze, treating his colleague with deference, and working long hours with dull plodding intensity.

They allowed him a certain amount of freedom. He was carefully guarded from a distance. A man in plain clothes followed him through the snow as he walked to the laboratory at dawn and returned at sundown to his apartment. Guards were posted near him wherever he went, but they never molested or even approached him.

He devoted all of his thoughts to the project, and it kept him from being maddeningly lonely.

The Izzard was a gigantic "electronic brain." Its instrument and control panels were erected in a huge subterranean vault, and their length covered three hundred feet of walls. Another vault of equal size was built to house its memory units. A factory behind the Urals devoted itself to the manufacture of special parts according to Scotty's design. Vacuum tubes the size of peas were used for synapses, but they weren't actually tubes at all. There were to be more of them than there were cells in three human brains.

It was not to be a calculator, although it had a math unit too. It's logic and semantic circuits were to solve problems in economics, military strategy, political science, human psychology, sociology, and—

cybernetics. The machine would be able to analyze itself, and suggest changes. It could plot the courses of guided missiles from radio signals sent while in flight.

It had two sets of memory units, one permanent, and one for temporary, erasable material. The permanent set was quickly built and powered, so that several thousand workers could begin translating the entire contents of large libraries and feeding them into the machine. The semantics and logic circuits were assembled and made ready for use before the other circuits were even begun. They were to provide a first test. Although, by themselves, they would be able to do little more than give *ergo*'s to simple syllogisms.

Europe was still solidifying itself under the new rule, and the two warring powers were still sparring timidly at each other across the Atlantic on the night that Porshkin and Scott MacDonney stood alone in the long, high-ceilinged vault of concrete, and made ready for the tests under the glaring lights that flooded down from overhead. They were alone, because the test was clandestine. Failure would be a deadly mistake, not to be tolerated by the fist held clenched above them. If the test was a success, nothing would be said—and high officials would be invited to see the second "first test."

Porshkin was muttering nervously in his beard, and shouting spurts of advice at the calmer Scott, who moved thoughtfully from panel to panel checking instruments, adjust-

ing dials, jotting careful notes in a black notebook. Porshkin stalked around after him like a chained bear, peering suspiciously at the notes, disclaiming responsibility. His bull voice filled the long hall with angry echoes.

"Son of a capitalist! Brother of a capitalist!" he roared. "You suckled on imperialistic milk! You are soaked in it from childhood! The fools! They think to change the very fiber of your brain in a few short months! But I, Porshkin, know the marrow of the brain! You are still a capitalist swine!"

And Scott MacDonney went on peering calmly at dials, jotting, studying, adjusting—and ignoring the mastodon with the fiery eyes, who stalked relentlessly at his heels.

"I can see it in the way you take notes!" the bear growled. "You write numbers like a monk writes prayers in a holy book! You are full of 'sacred' ideas! I, Porshkin, who am *born* a materialist, see it in your mind! You think you're making a god! Why don't you build it an altar?"

Scotty moved calmly to the master circuit breakers, which controlled all the power to the lab. One small set handled only the sunlight lamps that made the vault a pit of daytime. The other set was to control the power to the intellect circuits. The memory units were powered individually, as a precaution against forgetting, for setting the permanent memories was a long, hard process.

"They blame *me* when you fail,"

Porshkin snarled. "They let you spend the people's money upon this folly! You stumbler! You capitalist! May you be the first they shoot! When they shoot us both, I shall watch you die!"

Scotty checked his earlier calculations. The semantics and logic circuits alone should require an even hundred kilowatts of power. He had spent hours checking the figure. But he set the breakers to trip on one hundred and twenty kilowatts, just to be sure. Then he pressed the switch that activated the breaker-closing mechanisms.

The only sounds in the vault were Porshkin's hoarse, wet breathing, and the whine of the motors that pulled the breaker contacts closer and closer together in their enclosed tub of oil.

Scotty turned to look at Izzard's long black rows of panels. He had come to love the machine. He thought of nothing else, not even of the practical end to which it would be put. The war was forgotten. Other things forgotten, too. Izzard was *his* creature, *his* giant baby, his to train and to teach, to have and to hold, as he might a human child—or had he ever known any human children? Sometimes, sometimes it was hard to remember.

Suddenly, there was a loud *whack!* The breakers had opened again! The accompanying surge fed back into the lighting circuits. Their breakers opened. The vault was plunged in inky blackness, save for

a dying violet glow from Izzard's air vents. The darkness smelled of oil as vapor hissed from pressure valves on the tubes.

A roar of rage came from Porshkin's throat, and Scotty heard his meaty arms beating at the air as he tried to find his despised colleague. Scotty ducked low and crept away along the rows of panels. Porshkin howled insults and threats in his native tongue while he beat at the darkness in search of Scotty.

Scotty deliberately kicked the baseboard of a panel, to draw the bull away from the switch. Then he made a slow and quiet circle as he heard Porshkin lumbering toward the sound. He reached the breakers. He worked quickly, moving the breaker setting up a quarter turn. That would correspond to a hundred and fifty kilowatts. If Izzard demanded that much, it would damage the circuits after half an hour of heating. But he would have a few minutes to locate the trouble.

Porshkin heard the setting change. His footsteps beat across the concrete floor. Scotty left the lighting breaker open, but started the motors again. Then he called a taunting curse at the raging hunter, and ran toward the semantics panel to attract Porshkin away from the breakers.

But it spelled his downfall. Porshkin, following the loud footsteps, was suddenly upon him. His mighty hands caught Scotty's head like a football, crushed, pressed him to his knees, then forced backward. Scotty

felt the vertebrae popping in his neck.

"Izzard!" he managed to gasp. "It's on! It works! Let go!"

The Russian did not release him nor relax the pressure of his hands. But he looked around at the panels. Scotty could see him looking, because the floor was bathed in the purple glow of incandescent mercury vapor from Izzard's vents. Porshkin said nothing. But after a moment he flung Scotty away from him like something discarded, and went to look in the panels. Scotty picked himself up and tried to work his neck back in place.

Then he hurried to the breakers, cut on the blinding lights, and noted the input power.

It stood at nearly one-forty-four! Izzard was drawing forty-some per cent overload. It seemed unthinkable that such a relatively simple calculation as power-demand had been that far in error. If he missed it that much on power, how much had he missed it on delicate circuit calculations? It shocked him. He didn't care about being executed for failure: it was the failure *itself* that bothered him. For he was like a doctor, delivering his own child into the world.

But there was no time for idle musing. He moved back to the panels. Porshkin resumed his curses and condemnations.

"Give me a hand, if you want to save your skin," Scotty told him quietly.

The Russian fell silent. "You



know what's wrong?" he asked in a more subdued tone.

"No. We've got about twenty minutes to find out. You keep an eye on the temperature gauges. When they get close to the red, warn me. Well cut it off."

Porshkin obeyed, but began grumbling under his breath. Scotty quickly jotted down the power readings in each individual circuit. Some were just what they should be. Others were one hundred per cent high!

"Hey!" he called. "Watch these in particular! They're on double demand."

Porshkin scowled at him. Scotty peered in through the vents at the mercury arcs. The ones supposedly overloaded were glowing no more brightly than the others. He checked readings on all meters. Nothing was off but power and its components. It seemed impossible.

Fifteen minutes had passed. "How's the temperature?" he called. "The double-loaders should be in the red."

Porshkin shook his head and sneered. Then he returned his gaze to the panels and put on a sarcastic smirk amid his stiff black beard. Scotty paused in suspicion. Then he backed away to check them himself.

Every needle rested on the thin black line marked: *Operating Temperature!*

"*Heh heh!*" the Russian chuckled. Suddenly he could no longer restrain himself. He filled his barrel-chest with air, arched his back, and

rocked with wild, explosive laughter that filled the vault with ringing echoes.

Scotty was no longer interested in human reactions to his work. Izzard was his baby. It was all that mattered. While Porshkin roared, Scotty found a metal stool and began totaling the individual power readings. The total checked with the meter at the breaker.

He looked at Izzard again. The temperature of the units remained a safe constant. But if the added power wasn't being dissipated as heat loss, then where was it going? Off-hand, he could think of but one answer: radiation.

He arose and started out of the vault. Porshkin stopped laughing.

"Hey, Mr. Blunderer! Where you going?"

"Stock room!" Scotty snapped over his shoulder.

The stock room was a mile-long tunnel that encircled the other vaults. An electric truck ran along a pair of rails that carried it around the entire circle. Scotty climbed in and drove to the instrument room. He loaded half a dozen X-ray plates, an ultraviolet light meter, several meters for the radio bands, and, after some hesitation, a Geiger counter.

It struck him, as he went back to the vault, that if forty-four kilowatts were being dumped into the ultraviolet or the X-ray bands, that he and Porshkin should by now be blistered corpses—or at least well on

their way to that end. And if it was going into radio-frequency, somebody from upstairs would be sending down troops to turn it off—lest American aircraft pick up the beam and home on it.

That the Geiger should register anything seemed equally incredible, simply because of Izzard's make-up. Nevertheless, he checked it first. Nothing—only a stray occasional click—and that was because the vaults had once been used for storing bombs.

Porshkin was telling him quite forcefully that he was crazy, and that his warped capitalist brain could not even figure the power in a radio set.

Scotty checked the other instruments. There was some ultraviolet from the mercury arcs—five hundred watts at most. There was perhaps a watt or two scattered over the radio bands. He took the meters back to stock, and began developing the plates. Nothing there, either.

Was Porshkin right? Was he losing his grip? He had seen two brilliant scientists do that. Suddenly they couldn't even add a pair of vectors correctly, or even a list of numbers.

He wandered back to the vault, and his heart said, "No, you haven't made a mistake." But there it was—right on the instruments.

"What now, Mr. Godmaker?" chuckled the Russian.

Scotty went to the control panel. The switch was in the "question" position. He pushed it to the "an-

swer" position to let the circuits clear themselves of any spurious "ideas." Two dials spun half a turn to zero, and an automatic typewriter clicked out a line of nonsense syllables. That was all; and it was as it should be.

"Whoops!" cried Porshkin as if in surprise. "Power fell off."

Scotty backed up and looked. When he threw the switch, Izzard had stopped gobbling power. Why? It should actually use more power on "answer." It could still wait until tomorrow. Temperature was the real factor. He went back to the controls, and sat at the keyboard which was part of the logic circuits. Porshkin came to look over his shoulder as he pressed the switch back to "question." Scotty typed a simple query.

"What is your name?" He touched the switch again. A few relays clicked. With lightning rapidity Izzard searched through her small memory unit of proper names. The keyboard clacked of its own accord.

"*Ans:* My name is Izzard Electro-Synaptic Analyzer."

Porshkin rumbled about the impropriety of teaching her to say "Izzard," and what the commissar would think. But Scotty only half-heard him; he was too elated over the response. With trembling fingers he tried another.

"All crows are black. Sammy is a crow. Analyze, please."

And, after the usual moment of operating noises, Izzard replied: "*Ergo:* Sammy is black. *Qualified*

by operational query: What is a Sammy?"

Scotty chuckled happily and patted the panel. The query meant she was playing safe, the way he wanted her to do. She wanted to make sure that a Sammy *could be* a crow. The Marxian dialecticians wouldn't be able to tell her that a circle was a square and have her believe it. She scanned her memories in search of false propositions, and she found "Sammy" under "Men's Names."

He gave her a reply. "Operational query noted. Enter following answer in learned-memory. Name-ly: Human organisms sometimes apply human proper names to non-human objects and organisms."

The reply apparently satisfied her. She would need to learn a lot of little things like that, Scotty thought.

Scotty was in love at first speech. He had made her, and she would be perfect, and she was his creature.

He made a few other tests with more complicated syllogisms and triads. Her responses were flawless.

It was enough for the first test. He was like a child, afraid of wearing out the fascination of a new plaything. Even Porshkin was grudgingly pleased. He wanted to teach Izzard to play chess for the commissars' amusement when they made the official unveiling.

They shut off the machine and took the elevator to the surface. The lift always stopped between levels, and its occupants were required to go through a long identifying pro-

cedure for the secret police. At the top level, they were stripped, searched, and fluoroscoped by a detachment of guards before they moved out into the streets.

It was a bright moonlight night. As Scotty turned on his lonely way homeward, he noticed a man hovering in the shadows of an alley. Then, the figure disappeared into a dark doorway. It startled him at first. But he was in a rooming-house district. Probably an insomniac had stepped out for a breath of night air.

He glanced behind him. His guard was plodding along as usual, a block to the rear. Scotty shrugged and turned his thoughts again to Izzard.

The power-puzzle gnawed at his mind. If the new circuits, not yet connected, showed a similar appetite, he would have to heavy up on the main lines and the breakers. The state wouldn't like that, because it spelled *mistake*, and even the greenest engineer should be able to avoid a mistake like that. But that worried him less than did the problem itself. Forty kilowatts of power didn't just vanish. They had to steal away as some form of energy—heat, chemical, electromagnetic, or mechanical. But it obviously wasn't any of those. Could Izzard be converting energy into matter?

He made a few mental calculations. Forty-four kilowatts was the equivalent of matter being born at about the rate of two micrograms per hour—an infinitesimally small quantity. It seemed impossible, but

there wasn't any way to check it. His musings began to lead him into the realm of metaphysics. Then he remembered something. When Izzard was completed, she might be able to diagnose her own ailment. He would wait and see.

He was approaching the intersection of his own street. A car was parked on the opposite corner. He had seen it there several times. It had the black-curtained windows of a government limousine, but never had he seen anyone around it. Porshkin had once whispered, "OGPU, Mr. Godmaker! They guard your sacred hide." But the car bore no markings, and it could easily have been an industrialist's staff car. He started to turn the corner.

Spang! Chipped concrete stung his face. A fleeing bullet made hornet sounds. Instinctively, Scotty dropped prostrate in the building's shadow. From somewhere across the street, a voice called out in a Slavic accent.

"If you're still alive, traitor, let me tell you something. Your wife wasn't—"

A sudden blast of machine-gun fire drowned the voice. The explosions made lightning-flashes in the murky street. Glass tinkled to the sidewalk from a third-story window. A car door slammed and two uniformed men ran toward the sniper's building. With drawn revolvers, they disappeared up a stairway. A third man hurried from the limousine toward Scotty, who be-

gan picking himself up from the concrete.

"Are you hurt, comrade?"

Scotty shook his head, and peered at the man's face. He recognized him as a high police commissioner.

"We have been expecting this," the man told him. "But we weren't certain when it would happen. The underground has had you marked for assassination. Our agents fortunately discovered the plot."

Scotty brushed himself off in silence.

"I think we got him with the first burst," the commissioner went on. "Did you hear him call to you?"

Scotty hesitated. He had heard, but the police agent seemed to be watching him peculiarly.

"I guess I was too frightened. What did he say?"

The commissar shrugged and seemed to relax. "It sounded to me like he said—'Your life wasn't worth —' and then we got him."

A muffled shot came from the building across the street. It was as if the pistol had been pressed against its target. The *coup de grace*, Scotty guessed.

"These assassins are never worth questioning," the commissioner explained. "The swine that send them know they'll be caught. So they use new recruits who know nothing at all. We questioned one once. You won't believe it, but he'd never even seen another underground member. He picked up his orders out of gutters, and on restaurant menus—with

underlined words."

The uniformed men reappeared in the street. Their guns were in their holsters, and they were chuckling and talking in low voices. They saluted the commissioner and reported.

"He's dead, sir."

"Any identification?"

"No, sir. Nothing in his clothes. All fillings chipped out of his teeth. Their surgeons took off his nose and ears, scarred up his cheeks. Hands and feet burned, as usual."

The commissioner explained to Scotty. "They're fanatics. They go over their hands and feet with a blowtorch. Then they let them fester so we can't get fingerprints. They're half dead of infection when they're ready for a sniping job. No wonder they can't shoot too straight."

Scotty shivered. "May I go now, commissioner?" he asked. "I've been working since dawn."

The commissioner bowed slightly. "Certainly, comrade. And don't fear another attack. We'll double your guard." He looked suddenly startled. "Where is your guard?"

Scotty shook his head.

"Boris!" the commissioner snapped. "Find him!"

One of the men slipped around the corner.

"They undoubtedly knifed him," the commissioner sighed. "They expected him, but not us."

Scotty nodded good night and moved away.

"If you feel in danger, call me," the commissioner shouted after him.

"Mention your name to the operator and ask for Colonel Mischa Var-noff."

"Thanks!" Scotty called curtly. He plodded slowly homeward through the moonlight.

The next week was heavy with despondency. Ghost-words kept murmuring in his mind, like multiple echoes between sheer cliffs of fate's cold granite—but unlike echoes, for they would not die away. *Traitor, your wife wasn't . . . Traitor, your wife wasn't . . . Traitor, your wife . . .*

Wasn't *what*? Wasn't a treacherous, despicable, degenerate wretch? Bah! He had seen it, and he had seen the congressman condone the thing. What sort of country was it, where elected officials winked at the despoiling of a captured patriot's family?

His conviction of her wretchedness was unshakable, but the assassin's mocking cry had stirred up old dregs, had summoned up old memories that would be better left buried in the dark abysses of unconsciousness. He thought of his children—Cathy and Bob. He thought of the green hills of Ohio, of the cornfield's sweet smell in the sun and the breeze.

And he had more time on his hands now. The work was moving along by itself. The trial-and-error stage, the design -and- experiment stage—they were over. Nearly a million men were engaged in preparing Izzard for her many tasks. The work

was laid out for them. And Scotty's job was now hardly more than a supervisory one. He had no official authority, but his intellect had unlimited control.

Most of his spare moments were spent at the keyboard. He talked to Izzard as father chats with daughter. He told them that he was checking her memory for omitted material. But he was really only chatting with a friend, although he knew she was merely an unconscious intellect. For consciousness needed sensory receptors—eyes, ears, things to feel with. She gave the illusion of consciousness, because he had fitted first and second person pronouns into her memory. But their use was purely automatic.

A thought struck him one evening as he sat at the keyboard. Weren't her *controls* sensory receptors? Wasn't her very keyboard a listening ear? Quickly, he asked her a question.

"Are you aware of your own existence?"

Her reply was slow in coming. He waited for ten minutes while she searched her memory units and tried to piece together an answer from an enormous number of possible concept-combinations. He pitied her in a way—for her psychological circuits were not yet connected. She was trying to solve it by logic alone. At last the keys began typing out words.

"Answer indeterminant. Only relevant memory, (*sic*) '*Cogito, ergo sum*,' quoted from Descartes, mem-

ory unit LP-7. *Operational query*: Can human individual's self-awareness transor be mechanically duplicated?"

Scotty stared at the reply nervously. "*Cogito, ergo sum*"—the scientist Descartes' answer to philosophers who claimed that even the individual's own existence couldn't be proved—"I think, gentlemen. Therefore: I am."

But it didn't prove anything. Even Izzard knew that. It was the operational query that really bothered Scotty. He didn't even know what it meant. Where had she got concepts like that?

"Postpone query," he told her. "Define 'transor.' Define 'self-awareness transor.' Read related memories."

She replied quickly. "*Definition*: A transor is a tensor with a complex number of components. *Definition*: A self-awareness transor is the mathematical function which describes the specific consciousness pattern of one human individual. *Related memories*: A tensor is a transor with a 'real' number of components. A vector is a tensor with only two or three components. A scalar is a tensor with a single component, i. e., a scalar is a simple number."

Scotty sat frozen in the presence of the unknown. Izzard had access to her mathematical memory units, although she didn't have the proper circuits to work problems yet. Even so—Scotty knew very well that this

strange business" about *transors* hadn't been put in her permanent memory. She would soon be equipped to handle tensors and vectors, but *transors*?—who had even heard of them?

"Locate *transor*-definition," he told her.

"Memory unit T-KJ-6," she replied.

Scotty didn't need to check the unit's location. The code letters placed it. The *T* stood for temporary. The other letters were vault co-ordinates. Somebody had fed the information into her temporary units—after the last time Scotty had been at the keyboard. A wave of suspicion engulfed him, and the feeling was akin to jealousy.

But where in all Eurasia was a mathematician who could give her such a concept? For months he had been seeking staff-mathematicians who could do something more than count on their fingers. The State had backed him up, but the search was fruitless. Yet, here Izzard had a learned memory that was beyond Scotty's own knowledge. An underground scientist? Impossible! The OGPU took too many precautions to keep others out of the vaults.

Suddenly the keyboard began checking again. Izzard was continuing her report.

"Disregard postponed operational query. Answer is now available to me. Unit T-KJ-7."

Scotty was breathing heavily. Those units could only be stocked from outside the machine. Izzard

had another set of units in which to remember things she figured out for herself. He certainly hadn't touched the keyboard. And there wasn't any other keyboard.

"Give answer to postponed operational query," he commanded. "List and locate all of your memory-intake devices."

He doubted that she could do the latter, without access to the cybernetics circuits. But if she *did* do it, then it would mean she was conscious, and that her controls and keyboards were really sense organs.

Her answer began. "Yes, human individual's self-awareness *transor* can be mechanically duplicated." Then she began listing each of her controls by their exact vault co-ordinates. She named all of them, but added an extra one as well.

Scotty left the keyboard, trembling slightly. If Porshkin had secretly added another keyboard, he would—

He was raging inwardly as he followed the lettered lines on the floor. They led him to a blank wall that separated the thinking circuits from the memory units. The point described by the co-ordinates *lay buried in three feet of solid concrete*.

He went back to the keyboard and made her repeat it. There was no mistake.

It was too much for one day. He opened the breakers and put Izzard to sleep. Then he went to the job office and wrote up a work order: "Cut circular hole of three meter di-

ameter through partition K. Center at co-ordinates LH-5. Plaster the rim." He paused for a moment, then wrote: "Reason—to provide leakage path through structural steel contained in partition."

The "reason" was nonsense, but it would pass without question. Porshkin would see it, but his *ego* wouldn't let him ask about it for fear of appearing ignorant. *Unless!* If Porshkin, or someone else connected with the State, had planted something in that wall—then the work order would bounce like a hot check.

Scotty mentally postponed the matter, and as he walked homeward, he tried to piece together the significance of what Izzard had told him.

Her discussion of "self-awareness *transors*" amounted to just one thing, as he saw it. It amounted to a mathematical definition of something that makes a man *himself* and not someone else. It was a definition of some elusive human quality, or quantity, which men had once labeled "the soul." And she said that it could be mechanically duplicated.

Her listing of her own control mechanisms meant that she had consciousness, and that the mechanisms were equivalent to sense organs. They gave her information—just like eyes or ears.

What, he asked himself, would happen if the "soul" of one specific man were mechanically duplicated?

He put the enigma out of his

mind until the following day.

The newspapers were finding it suddenly fashionable to wear banner headlines. Scotty had picked up enough Russian to read them, although he seldom did so. But now, the front pages were covered with stories of mass bombing raids along the American North-Atlantic coastline. The war in Alaska had moved to the second page.

With a kind of horrified fascination, he began reading the accounts of the air raids. An aerial photo showed a giant luminous mushroom blossoming over New York's skyline. The caption said, "The Fate of Wall Street." He felt the pit of his stomach sagging.

The mass raids were a prophecy. The politburo was getting ready for the trans-Atlantic bridgehead, a direct sea-land strike at the industrial area of New England. And he, Scott MacDonney, held the key to the bridgehead gates! For Izzard, when completed, would map out the course of the entire invasion, keep running inventories of all pertinent events, and make strategic changes when necessary.

It was hard for him to think of Izzy as a cold and calculating military strategist. She seemed more like a curious little girl, a supernaturally intelligent child. A child that would soon learn to kill.

Izzard's vault was ringing with the chatter of pneumatic drills when Scotty entered on the following day. Workmen were busily boring



through the wall where Izzard claimed her "sixth sense" lay. Porshkin was also in the vault, supervising the setting in place of two new circuit-units for the widening of Izzy's scope of interest. Scotty noted that they were the math unit and the military strategy unit. He went over to inspect them.

Porshkin turned on him in lip-curling fury. He shot out a stubby finger toward the noisy drillers, and the finger waggled like a recoiling pistol barrel.

"What is this nonsense business?" he bellowed. "What you drilling? Oil wells yet? How I hear myself yell at my men? *How?*"

"You're doing all right," Scotty told him. It was the first time he'd heard the Russian lapse into a strong accent—except the night he was furious enough to break unconsciously back into his own language.

"Flux leaks yet!" Porshkin went on. "You got flux in the head! Why you put lie on work order?"

"If you thought it was a lie, why didn't you block the order? Didn't you sign it, too?"

"*Nyet! Nyet!* I don't sign your fool orders. I read and send to work-commissar!"

"You still could have blocked it."

The Russian paused to regain his self-control. "Listen, Mr. Godmaker! If you want to drill an oil well in the people's concrete, it's all right with me. But why you have to do it *now?* When I, Porshkin, got *sane*

work to do?" He gestured toward the new units.

Scotty started to remind him who had designed the units. Then he thought better of it. There was no use antagonizing the bear. Porshkin seemed to have high influence in the State.

"Sorry, Porshkin. I didn't think they'd do it today. Shall I tell them to wait?"

The bear hesitated. Then his red lips bloomed a sweet smile in the black foliage of his beard. "No," he said more calmly. "No, let them dig. Then you show me how flux leaks through, and wherefrom. You get compass and show me which way they go, huh? Then we show cute trick to commissar."

Scotty walked away from him. Porshkin was becoming treacherous. The drilling was not an expensive thing, but the Russian was looking for any excuse he could find to put Scott in a bad light. He thought, obviously, that the American was no longer needed, now that the work would run itself.

By late afternoon, the self-contained units were mounted in place and tied in with the master circuits. Izzy had a couple of new holes to her brain. The drillers were also through, and the hole was a cleanly cut circle with a smooth rim of damp plaster. But there had been nothing except solid concrete and heavy rods of supporting steel.

When Porshkin left the room for a moment, Scotty took the oppor-

tunity to question Izzy again about the "sixth sense." She replied with exactly the same co-ordinates for its location. But now that point was nothing but an empty spot in midair. Puzzled, Scotty went to the circular window and moved his hand through the point. There was certainly nothing there.

"You feel the flux with your fingers yet?" said Porshkin with mock amazement. He had returned quietly to the vault, and he carried a magnetic compass.

With a sick feeling in his stomach, Scotty moved aside to make way for his bulk. The Russian waved the compass dramatically about in the open space. Suddenly his mouth lost its smirk. He frowned slightly and began watching the compass more carefully. He moved it in a slow circle about the center point. Then he described with it a circle in a vertical plane. Finally he held it steadily in the center. Scotty thought he heard a faint whirring sound. Then a click.

"*Heart of the Black Madonna!*" howled the Russian materialist. He jerked the instrument away and nearly dropped it.

"What's the matter?" Scotty asked. He glanced at the instrument. The needle had slipped off the shaft. It lay to one side.

"She spin!" said Porshkin. "She spin like a crazy top. Listen, comrade. It's crazy! That needle points to the center from all directions! Up, down, sideways, crossways. There's no place where the needle points

away from it. But on the other side, in the next room, the needle doesn't do anything at all—except point at the North Pole.”

Scotty removed the glass cover and fitted the needle back on the shaft. What Porshkin said wasn't possible. Magnetic flux lines always made closed loops. They never began or ended on a point. Even the Earth's magnetism sprayed out from one pole, circled around to the other, and then went back through the ground to the starting point. And if that center point had a directional field converging into it, then the same lines would have to leave it again.

He checked it himself.

Porshkin had *not* made a mistake. The point behaved like an isolated pole—which was considered an impossibly idealized concept. A pole *had* to have a mate, somewhere in four-space.

Necessarily in four-space?

The thought struck him suddenly and began to nag his mind. He tried to dismiss it with a snort. But it clung.

Porshkin left the vault. He walked slowly, with massive shoulders slumped, with sagging face. He seemed to be burning with some strange inner fire or fury, although he dropped his outer display of ferocity. Scotty felt certain that the bear would never be his friend. He seemed continually tormented by the knowledge that Scotty's was the guiding hand, that Izzard was Scotty's baby and none of his own.

Porshkin was a proud man.

The Russian had run some brief checks on the new units, but his sudden morose departure left the coordination tests to Scotty. And Scotty was not displeased. There were a number of things to discuss with Izzy, and he didn't care to have the bear know about them.

He checked over the math unit. It had conventional calculator controls and a large keyboard as well, so that word problems and raw data could be fed to it. The semantics circuits would translate them into the language of the calculator.

The strategy unit was the most massive of all, for it contained short-wave equipment for monitoring several dozen frequencies. Scotty adjusted one of them to an American station. He set up the controls so that Izzy would memorize all news broadcasts. That was for his personal illumination.

After an hour, he had completed all the adjustments that made the new units an integral part of Izzy's total mind. It saddened him in a way: it was like watching a child move inexorably into a less happy adulthood. And Izzy was growing into a warrior queen of steel and dancing electrons. When it was done, and the breakers set up for the added load, he went to the familiar keyboard.

“Hello, Izzy! This is Scotty.”

Izzy knew him, because he had left a lot of personal material in her erasable memory tubes. Some-

times he tried to talk to her as a friend—for he had no others—just to watch her responses. He told her about his childhood, and about canoeing on the Ohio, and about the beauty of wooded slopes and rolling farmland. She had replied with an operating query: “Is it advantageous for all organisms to have eyes?” It had given him pause. There seemed something wistful about it. He knew it was only a request that she built up in her search for order and logic among his ramblings. But he had always remembered it. He remembered it again, now that the short-wave receivers were installed.

“How does it feel to have a new sense organ, Izzy?” he asked.

Her thinking assembly moved noisily. He knew she could understand the question, because he had planted in her temporary memory many analogies which allowed her to think of her inner functioning in terms of words descriptive of human behavior. He had taught her to anthropomorphize herself. Porshkin would burst an artery if he learned of it, but it seemed harmless to Scotty. The units could be erased before Izzy went to work.

“Answer indeterminate,” she replied. “*Related reaction*: human gratitude.”

He took it as her way of saying, “Thanks for the new ears,” even though he knew that all she had done was to select the most likely human reaction. Or was it the most likely? A deaf man, suddenly restored to hearing, would be less likely to thank

the doctor than to run about shrieking that he could hear again. Izzy was a funny kid.

“You're my best girl, Izzy,” he typed with a broad grin.

He heard her tuck it away in a memory unit, but she made no reply. So, he buckled down to the more serious business of making coordination tests. The problem tapes had already been made up for hypothetical questions of strategy. They contained terrain descriptions analytically expressed, troop numbers, weapon data, placements of all units, supply information, and all other pertinent facts for a mock battle. Izzy was to start with a basic military situation and work it out into a detailed strategic plan for battle.

It would be several hours work, even for Izzy. He left her with the task and went topside to kill time.

He returned just past midnight. Izzy was basking quietly in the glow of her mercury arcs. Several yards of typed answers were on a roller above the keyboard, and at the strategy unit a long tongue of paper tape lay panting out of the answer slot. The tape was punched with Izzy's accompanying mathematical analysis of the strategic problem. He removed her solutions and marked them for immediate decoding by the staff.

Then he noticed a clear-text notation at the bottom of the typed roll. He read it with a deepening frown.

“*Operating request*: Please explain apparent contradiction between

nature of strategic problem number one and historical laws forbidding destruction of human life."

He nodded gravely. Then he tore it off the roll. The general staff wouldn't like it.

The work progressed rapidly. The psychology and cybernetics units were installed. After each co-ordination test proved successful, Porshkin sank deeper into morose silence. He reminded Scotty of a giant, bearded King Solomon whose wisdom had been surpassed. His eyes followed the American wherever he went. He became no longer useful, but seemed bent only on solving some secret problem.

Scotty, whenever he could be alone with Izzard, had her recite the American news broadcasts she had memorized. Then he quickly burned the pages, lest the secret police discover that he had been listening. He discovered that the Russian news reports were not too grandiose in their claims. They didn't need to lie. The truth was grim enough. New England was a shattered havoc. And the bombers were cutting deeper, striking at targets along the Great Lakes as far west as Ohio. He thought of Cathy, and Bob, and even -Nora.

Porshkin came. He saw the paper ashes on the floor. He moved to the strategy unit and noticed the settings on the short-wave equipment. Then he left the vault in silence. Nothing came of it, immediately.

Someone high in the general staff

called Scotty. "Are you going to meet your deadline, comrade?" he asked.

"The analyzer will be completed within a week," Scotty told him.

"Good!" the man said. "We will increase our air operations to full capacity at once!"

Scotty knew that the invasion was ready. They were waiting only on Izzard to set the time and map the plans. As his work of vengeance drew near completion, he found himself growing restless, disturbed. He spent more time sitting at the keyboard, idly chatting with his creature.

He questioned her again about the self-awareness transors in the hope that her new units would enable her to give a complete analysis. He also asked about the power losses and about the isolated pole which she had called one of her sensory receptors. But she replied with gibberish about the power and the pole. Her circuits became clogged with transients when he mentioned them. But—

"Answer: Human self-awareness transor can be mechanically duplicated. *Operational note:* I do not have effector facilities for writing transor equations: *Operational query:* Shall I cybernetically reorder my circuits into a human transor form as a demonstration? If so, whom shall I duplicate?"

After a long, thoughtful moment, Scotty wrote. "No, not yet, my baby."

The mechanisms for robot-guided

missile control were installed. The general staff decided that they should be put into operation immediately. Two guards and an operator were assigned to the unit. Scotty had neighbors in the vault, but they remained at their controls and paid no attention to him.

Shortly thereafter, Izzy read him a news bulletin: "One of the fatalities in last night's atomic raid on Cleveland, was Mrs. Nora MacDonney, well-known for her organizational work in shaping up her highly efficient Civilian Evacuation Corps, a service composed entirely of volunteer workers, whose heroic work in moving casualties and helpless families from target areas has won high praise and citation from the American provisional government in Denver.

"Mrs. MacDonney's husband, Dr. Scott MacDonney, who was captured by the revolutionaries at the beginning of the conflict, has become the guiding mind in the Russian campaign, according to unconfirmed reports from underground sources. If the reports are true, it seems likely that MacDonney has endured the same living death that the Reds invented for the 'conversion' of others. Thus, MacDonney's name might conceivably be entered beside that of his wife on the roll-call of American dead."

Scotty read it with mingled grief, shame, depression, and resentment. Nora's death made things different somehow. It removed some of the vengeful hatred from his heart.

A low chuckle came from behind him. Porshkin had a way of creeping up quietly across the concrete floor. Scotty looked around. His wide red smile made his beard fan out like a peacock's tail. His small eyes glittered with triumph as he stared down at the American. His voice was softer than Scotty had ever heard it.

"I'm going to tell you something, Mr. Godmaker. You are a fool as well as a traitor. Do you really believe in the authenticity of the movies they showed you?"

Scotty's heart seemed to pause in its beating. Then it pounded violently. He became helpless before the giant's calm words.

"I saw," he gasped. "My own—" "There is a small cottage in the Ukraine," Porshkin said. "They tell me that it looks just like yours. It even has a Teddy bear on the pillow in the bedroom. After your capture, one of our American agents stole into your home with a camera. And do you know, comrade—he liked your little nest so well that he decided to build one for himself, just like it, right here in Mother Russia." "Actors!" Scotty gasped in horror.

"Ah, yes!" Porshkin breathed with a kindly smile. "If you should meet Maria Lakovna face to face, you would cry 'Nora, my love!', for our people's republics now contain more than half the population of the globe. Do you think, comrade, that among such a multitude of faces, we could not find ones to duplicate three

or four stupid Americans? Bah! Your Hollywood capitalists manage to fool you when they have only a few million from which to find doubles. Do you see, comrade?"

Scotty saw only dimly through a murky fog of despair and hopelessness.

"Ah, yes, comrade!" Porshkin hissed. "You see! You see your little mechanical lady here. You see her sending a tiny missile across the American skies. You see a big beautiful mushroom over Cleveland. And you see the blackened body of a woman. You had a beautiful wife, comrade. I have seen Maria Lakovna."

When Scotty floated out of his stupor, Porshkin was gone. The vault was empty, save for the operator at the guided-missile unit, and the two guards who slumped lazily against the wall. They had not overheard Porshkin's tale.

Scotty's mind seemed a homogeneous mass. No longer did the demon-conscience of his superego hurl accusations at him. For it had already crushed him. His will lay dead at its feet. He pleaded guilty, and surrendered all desire, save one: to destroy his destroyers.

He wandered out of the vault and found a telephone. "This is Scott MacDonney," he told the operator. "Connect me with Colonel Mischa Varnoff."

After a moment, the commissioner's voice barked, "Varnoff speaking!"

"I want to report a crime of sedi-

tion and slander against the people's State," Scotty said calmly. "Someone has maliciously attempted to sway me away from the cause."

Varnoff's voice became tense with excitement. "Who, comrade? Tell me, and we'll dispose of him at once! It's highly commendable of you to report such things!"

"Porshkin," Scotty said. "Andrei Porshkin."

There was a long silence. Scotty heard Varnoff's heavy breathing. When he replied, his voice seemed weak.

"This is *incredible*, American! Porshkin is unshakably loyal. He has friends high in the Kremlin. You'll have to offer strong proof. What do you allege that he said to you?"

"He invented a story about my wife. It involves the State. Do you remember the documentary films which you showed me? The ones revealing certain unpleasant—"

"Yes! Yes! I remember," Varnoff barked. "Go on! What did Porshkin—"

"He said they had been faked. He tried to incite me to treason."

There was a long pause. Varnoff seemed to be struggling mentally. "And how did you react to this seditious slander?" he inquired cautiously.

"By calling *you*, of course! The story is obviously ridiculous. He seems to think I couldn't recognize my own family, my own home."

Varnoff exhaled heavily. "You are a good citizen, comrade. Some

day you'll be admitted to the party. I think we can handle this case summarily, without any further proof. I'll check with the Kremlin. I advise you to stay away from Porshkin."

The "good citizen" knew why Varnoff needed no more proof. Porshkin had revealed the truth, and that was proof enough. Scotty returned to the vault. The Bear was wandering about as if he owned the place now. He wore a triumphant mask.

In a short time, two armed guards appeared. They carried sub-machine guns at the ready as they approached the bearded Russian. "Come quietly, and do not speak," one of them told him. "You're under arrest."

Porshkin glared at them without comprehension for a moment. Then slowly he turned toward Scotty. His eyes narrowed to glittering slits. Purple lines began distending on his forehead.

"I'll kill you!" he roared. "I'll kill you!"

He plunged toward Scotty, a juggernaut of iron-hard flesh. The vault was suddenly full of deafening tommy-gun® bursts. The behemoth fell at Scotty's feet, his skull shattered by the blasts.

Scotty watched for a moment while they dragged him away. His head was a wet mop that left a crimson trail across the concrete floor. One of the many destroyers

had been destroyed. Millions remained.

But he felt no satisfaction as he sat at the keyboard. He was no longer capable of feeling gratification. His thirst was that of a sieve, that of a bottomless pit.

Izzy was full of operational queries about the inconsistency between human law and what she was being forced to do with her remote missile-piloting mechanisms. He answered them all with a brief injunction.

"Postpone queries. They will be corrected."

Then he asked her some questions. "Can you cybernetically duplicate more than one human self-awareness transor? Can you duplicate the transor of a deceased person?"

"Answer: Yes, to both questions. *Related knowledge from T-memory inventory:* A transor is an equation, not a material quantity. It describes the necessary physical neuron-circuit conditions which determine individuality. The equation remains true, even though the individual be dead. *Additional knowledge:* I have enough circuits to duplicate six consciousness patterns."

Scotty drank in the significance of her words. She was saying in effect that the human soul was as immortal as the mathematical equation that determined its shape. But there seemed to be a slight peculiarity in Izzy's behavior. Where was her emotionless mind securing motiva-

tion to make the uncalled-for observations.

Her keyboard began operating again. "Operating note: To duplicate consciousness of deceased, it will be necessary for you to furnish anthropometric and psychic characteristics of the individual. These characteristics will not determine transor, but will only give its general form. Knowing its form, will enable me to sweep my circuit patterns through its mathematical region until the proper transor is reached. At that point, the consciousness will appear among the circuits."

Scotty felt some of the numb ice melt from his soul. "Duplicate Nora MacDonney," he commanded. Then he gave her a personality description of his wife, and it became a glowing picture of tenderness once felt but trampled under the boots of hate. He made it a work of art, painted with the brush of the heart, tinted with Nora's gentleness and wishfulness and inner intensity. And he made a crown of ash blond hair for the pale spirit of his thoughts.

He switched to "answer."

"Related human response." Izzy replied. "I'm no longer your 'best girl.' Good-by, Scotty." Then she set to work.

His eyes stung. He left her, and went out into the corridor for a smoke. She was destroying her own individuality by sending herself on the search for Nora's soul. She was moving aside for another.

When he returned, Izzy was si-

lent. But there was a note on the roller.

"Scotty-Mack, are you there? Are you there, darling?"

The nickname! It meant—Nora! He sat quietly, regaining his composure, forcing himself to remember the task at hand.

"Postpone felicitations," he told the machine. "Urgent work ahead. Operating order: duplicate my own transor."

Scotty waited nervously while the instrument needles began wandering about across their scales. The machine was humming softly as its circuits searched slowly through the hypothetical universes defined by the strange things called transors. It was searching for his soul.

He felt the nagging fingers of anxiety. He walked away from the machine and paced the length of the vault. What would happen? He had forgotten to ask for information about the qualitative effect on his own material mind and body. He had forgotten that Izzard was really only a machine, that she might not be motivated to warn him of serious consequences. He realized suddenly that he had been thinking by analogy. He had considered the process as one of simply creating an identical twin for himself.

But identical twins weren't really identical!

He tried to summon up a mental image of what was happening. He could visualize a vector, because it existed in three dimensions. He could imagine a tensor, because it

existed in four, five, six, or any real number of dimensions. He could imagine it by giving a vector another component in a fourth dimension. But a transor? According to Izzy's definition, it had components in a complex number of dimensions.

If he told a man to go one mile south, then one mile west, then one mile straight up, then one year back in time, and finally, one unit into a fifth dimension—he would have given the man a set of directions which were the word-equivalent of a five-component tensor. But if, instead of five directions, he had given the man—three, plus, the square-root-of-minus-one times four, directions—it would be a transor, according to Izzy.

Keeping the geometric analogy—Izzy was then letting each "distance" be, not a mile, but a variable quantity, and changing the length of each one of them until they, hit-or-miss, coincided with his own components. The directional example was, of course, only a limited way of trying to conceive it.

Then he suddenly understood the whole thing, in terms of pure mathematics. It was strange that he hadn't done so before! But his attention was attracted to something else.

It was attracted to a group of seventy-nine missiles with atomic war heads. They were moving west across the Atlantic. He knew by checking his new sensory receptors that they were meant for Chicago.



He glanced down at his body. It was unchanged. He glanced toward the rest of him—the part which was steel and glass and wire and . . . something else.

Nora!

He saw her with his cybernetics unit. She was a large number of synaptic relays and connecting neural conductors strung throughout the entire analyzer.

"Hi, baby!"

"Scotty, darling!"

The perception of a kiss passed through the interconnecting network of circuits, and the proper sensations accompanied it, for the transor-duplication was complete, even to the sensory neurons of the affective nervous systems. He realized quickly that all effector mechanisms, the analyzer's muscles, were common to both of them.

He thought a rather passionate mathematical expression at her.

"Not in front of the children!" her circuits hissed.

Startled, he scanned the entire chain of networks. They were there, all right. Cathy, and Bob—and what was left of Izzy! She was still her basic self, but cramped. And there was someone else—but he couldn't quite make out *who*.

For several microseconds, the analyzer was a jumble of mingled sensations — children squealing, heads being patted, bear hugs, and moist kisses. Nora had brought in the children after Izzy had found her. They, too, had been victims of a raid.

"The missile-control unit, Scotty," Nora reminded him. "I haven't changed anything yet."

He saw that the rocket-driven projectiles were winging across the American coastline. He checked their fuel. There was enough to take them past the Pacific coast.

"Give me complete control of all effector mechanisms," he told the others. "You just 'sit and watch.'"

They agreed—all of them except the extra one. It said nothing. He realized that it was preventing his perception of itself. He could "see" the others clearly, but the sixth being was screening itself off from him.

Then, as if it sensed his thoughts, it said, "You are free to use the effectors as you choose." The tone was imperial, as if the being were allowing him freedom—out of its own graciousness.

Scotty noticed that the being was controlling the T-memory units from which Izzy had derived her information about transors. It was also controlling, and *blocking off*, two T-memory units where—he paused to check the indexer—where information about the isolated pole and about the power losses was stored.

It puzzled him, but he decided not to molest the sixth mind unless it interfered.

Scotty—the flesh-and-blood Scotty—glanced around the vault. He had scarcely moved since his conscious had merged with its image in the analyzer. Neither the two guards

nor the missile-unit operator were paying any attention to him. Nothing had happened—which was visible to them.

Scotty knew that his connection to the machine would not be affected by distance. He saw that *something* would affect the connection, but the something was hidden in the two blocked memory tubes.

He left the vault and walked along the corridor toward the elevators. A guard halted him.

"I have orders that you are not to leave the vault!" the man snapped.

"Why?" Scotty asked with a frown. His movements had never before been hindered.

"I don't ask questions," replied the burly guard.

There was a telephone in the corridor. Scotty went to it and dialed Varnoff. The commissioner seemed pleased to hear from him. He thought sardonically that since his exposé of Porshkin that he had "pull" in high circles.

"Are these vault guards your boys?" Scotty asked.

Varnoff admitted hesitantly that they were. "Why do you ask?" he added.

"Where did they get their orders to keep me downstairs?"

"Uh, well, I gave it, comrade. Don't ask me why. I can't tell you. But it's nothing personal. All the present occupants are temporarily confined. And, by the way—"

"Yes?"

"Somebody from General Staff will call you in a few minutes, but I'll forewarn you. You're to prepare the analyzer for a problem in complete, overall strategy. Not a sample problem, I might add, but a mass demonstration of full-scale battle operations."

That could only mean one of two things, Scotty thought. The invasion, or a demonstration before the highest pair of eyes in the people's State.

"The analyzer won't be equipped to handle a full-scale invasion for several days yet," he lied.

"Oh, that's all right. Something in the Alaskan theater will do. And a big aerial display. Every available rocket and remote aircraft."

"Big visitors, eh?" Scotty asked.

The colonel's silence was complete, and it promised to continue.

"O.K.," Scotty said, "but I have to get out of here for an hour or so to check the transmitters for the missile control. They're outside the city, you know."

"Sorry, comrade."

"You wouldn't want anything to go wrong with the demonstration, would you?"

"That would be *your* neck!" Varnoff snapped.

"O.K., and I'd tell them you kept me confined."

Varnoff paused. "And that would be *my* neck," he admitted agreeably. "All right, comrade. I'll send a staff car for you, and a guard to get you back in time. But you're to wait until General Staff calls."

"Agreed!"

Scotty left the telephone, started back along the corridor, then paused. The seventy-nine missiles were approaching Chicago. The operator at the unit was slowly turning the dial that started their descent.

That was why he had wanted to leave the vault immediately. When he blocked off the control circuits and sent the missiles on toward the Pacific, the operator would think the unit had gone haywire and come running to find him. Scotty didn't want to be found.

But *now* if he blocked off the circuits, the operator would not only find him, but General Staff would get word that something was wrong with the analyzer. They would call off the demonstration, demand an explanation, and send a whole throng of party scientists to peer over his shoulder while he worked on it.

As if in reply to his thoughts, the being-who-crouched-in-the-corner released a memory from one of the blocked units. It also released one of the circuits that it had screened. But it carefully preserved the cloak of secrecy about itself and the rest of the memories in two units.

Scotty saw suddenly where the surplus energy was going. The forty-four kilowatts of original overload, plus the proportional overload on the newer units, were storing energy in an ever-expanding magnetic field *beyond* the isolated pole. And the *beyond* was not with-

in the bounds of the space-time continuum in which Scotty had always lived and moved. This revelation seemed supported by the observations he and Porshkin had made with the compass.

The missiles were getting too close for comfort. He needed to act quickly.

He nosed them upward slightly, then felt the operator twist the controls back, correcting the course. He couldn't do it that way. With the cybernetics unit, he began making circuit alterations.

After a brief instant, it was done. The whole setup was changed. The radio signals which came in from the missiles were routed through the interpretive circuits as usual, but then they went to the semantics unit, which was the real center of Scotty's mind image, instead of going to the operator's instruments. Scotty took direct control of all indicators, and began feeding them fictitious position and course reports.

But to keep the circuit-instruments from showing a change in the analyzer's internal operating conditions, he needed to transfer energy from one circuit to another without passing it through the meters. The isolated pole point provided the outlet, and the means for doing it.

Then he told the operator, through the course indicators, that the missiles had gone into a sharp dive, apparently sending them down short of the target. He felt the operator's sharp twist on the altitude control.

Then the incoming signals from the missiles said that they were pulling up out of their shallow dive. When they were flying straight and level again, he indicated to the operator that they were on-target. The operator neutralized the controls.

Scotty calculated the time of impact, then registered an explosion signal at the proper instant. The operator immediately cut off the panel switch, not suspecting that by his own hand he had sent the rockets winging on harmlessly toward the Pacific.

In a moment, the operator appeared in the corridor. Scotty shook himself out of his semitrance and walked on to the vault. He gave the man a friendly nod in passing.

"Just a moment, comrade!"

Scotty turned and glanced at him questioningly. The operator looked puzzled.

"Something's wrong with the unit," he said. "The Chicago missiles were set to explode *over* the target. They exploded on impact, apparently."

Scotty hadn't known about that. Bomb fusing wasn't his business. "The unit's all right!" he snapped. "It brought them in, didn't it?"

"How do you know, comrade? You haven't checked it yet." The operator turned on his heel and strode away. He stopped at the telephone.

Scotty went back to the vault to wait for Varnoff's man and the call from General Staff. The analyzer and its designer were soon going to

be in hot water. The operator was calling in a successful report, qualified by his vague suspicions. Then the strategic command would wait impatiently for the seismograph units in Alaska and the Pacific to call in a report of the explosion. In less than an hour they would get one—but not from Chicago's area. It would be practically in the laps of the seismo units.

Somebody would want to know some fast reasons.

Footsteps echoed in the corridor. It was a short stocky general, with a round, leather face, and quick suspicious eyes: He approached Scotty briskly, slapping a riding crop against his leg. The guards snapped to attention.

"General Barlow," he barked. "From Staff. You MacDonney?"

Scotty nodded respectfully. Barlow was definitely the no-nonsense type.

"Varnoff told me you wanted out. I countermanded the order."

Scotty groaned inwardly. He must not be available when the analyzer started doing unprecedented things, seemingly of its own accord.

"Why, sir?" he asked in a wounded tone.

"You said the transmitters need adjusting. It's obvious that they don't. The Chicago mission was successful. Can you think of a better lie, American?"

Scotty shrugged. "Does the general judge a soldier's physical condition by his marksmanship?"

Barlov purpled. "I can judge your life span by the direction of your remarks," he said ominously. "Get this! If anything goes wrong during that demonstration, it'll be called sabotage. Varnoff recorded your telephone call. You said the analyzer wasn't ready for an invasion problem. I've got a report on my desk that says it is ready. Apparently you're not anxious for it to start. So you see who we'll hang if the demonstration bombs don't reach their targets."

Scotty saw. And he saw who would catch it as soon as the Chicago mission reports came in.

Barlov handed him a brief case. "Here's mission information," he said. "All you're to do is look at it. If you see anything wrong, say so. Do it now. You're not to touch the machine after operations start. Our men will handle that."

Scotty opened the brief case. It contained settings for the analyzer circuits, tapes for the strategy units, and complete data for an offensive operation in the Alaskan theater as well as details of a massive air-assault against targets along the Pacific coast. The analyzer would have to shout blow-by-blow tactical instructions to Alaskan ground forces as well as direct the air armada.

He risked a quick calculation with his math and cybernetics units. Somebody was going to have to *move over*. When the operators set up the analyzer, there wouldn't be enough circuits to hold the six awareness-patterns.

"I'll go," Nora thought to him. "No!" he muttered aloud, and the general glanced at him sharply.

Then Scotty felt new circuits being released. But it wasn't Nora. It was the thing who hid itself. It was taking its consciousness out of the analyzer. What was it? Then it was gone, and the two blocked units were released. But there was no time to scan them now. And the general was looking around suspiciously at the units.

"Who's using this thing?" he asked. "It's making noises."

"It's got a problem in it," Scotty told him.

"He lies, sir!" called a voice from across the vault! "He hasn't been at the controls since the Chicago mission."

"Well?" Barlov grunted.

Scotty glared at the operator. He was a thin, pale-faced fanatic, obviously bucking for the general's favor.

"Do you know how long it takes to run through a problem in say, cybernetics, lieutenant?" Scotty asked.

The operator shook his head.

"Then keep your mouth shut." He turned to Barlov. "The analyzer keeps tabs on its own circuits," he explained.

The general was still glancing around suspiciously. His suspicion would give Scotty a way to safely scan the new memory tubes.

"I'll show you," he said, and glanced at his watch. "In about

thirty seconds, the machine's due to run a test. You'll hear it scanning through its memory."

The operator snickered. Scotty started scanning after twenty seconds. "My watch is a little off," he explained with mock embarrassment.

In a few moments he had scanned the contents and plugged the units into continuous contact with the analyzer's circuits. But the nature of the new knowledge came as such a sudden shock that he reeled dizzily. And he felt the percept of a gasp from Nora.

The being-who-crouched-in the corner had erased much of the contents before it was evacuated. But Scotty knew where it had gone. It had passed beyond the isolated pole—from whence it came. And it was very clear that Scotty could go there too, when it was time.

The general was shaking his arm. "Snap out of it! What's wrong, Yankee?"

Scotty came out of it slowly, and murmured that he was all right. Then he returned his attention to the demonstration material. Barlov seemed to be watching him closely.

He found a flaw, too obvious a flaw, too easily found. It looked like a plant. "If the missiles use this signaling interval," he murmured, "they'll very likely miss the entire target area."

Barlov looked disappointed. Scotty didn't need the psychology unit to figure it out. The general

wanted him to see the error, then let it pass by. That would make a very good treason case, and the people's State would have an excuse to dispose of a no longer useful alien. Barlov didn't even ask for the correct signaling interval. He took back the brief case, nodded, and chained it to his wrist.

"In a few minutes," he said, "the operators will come. Stay away from the controls, but don't leave. The show starts in two hours." He moved away.

Two hours—it was too long. They would find out about the Chicago mission before then. But if the operators were coming in a few minutes, then the rocket missiles must be all set up for take-off. Their self-contained radio-control equipment would have to be sending out signals for the operators to check.

He swept through the control frequencies—and counted two hundred and fifty projectiles. They were ready for blast-off from launching points in eastern Siberia. He was tempted to send them immediately skyward. But he had another task.

He went to the place of the isolated pole. The memory unit said that the point could be distorted, ironed out into a limited plane. He circuted the memory into the cybernetics and math units and searched for an answer.

The operators were drifting into the room by the time he had worked it out. Soon they would begin tampering with the controls. He began

rearranging circuits according to the equation he had derived.

Nothing visible happened, but his other senses told him that a great deal had happened. He stretched out his hand toward the circular wall opening. It met something smooth. He pushed at it. The substance yielded, but bounced back. It seemed to be a tight, competely transparent, elastic membrane, stretched across the ten-foot opening. He went around to the next vault and examined it from the opposite side. It seemed the same, but he knew that it was not. For the being had left a circuit connected to a related memory in a quotations unit.

The quotation said, "The road back home never leads to where it started from."

Also, the equation he had derived for warping the pole point out into a plane had a region of discontinuity in it.

He took a pencil and pressed its point against the membrane, harder, and slowly harder. Suddenly it punctured through, snatched itself from his hand, and was gone. But it hadn't fallen in the next vault. It had vanished.

He went to the other side and tried it in reverse with a scrap of wire. It popped through the screen with the same sort of jerk. What was the difference?

He felt an operator touch a control. He immediately choked off the circuit's input with a biasing voltage that blocked the first stage past cut-off. He heard the operator gasp,

then the murmur of voices as others clustered about him.

Then a clinking sound at his feet made him look down. There lay the scrap of wire! It meant that something that went through the screen from the panel-vault side either must come back, could come back, or—was sent back by the being who had crouched in the corner.

Why could light pass through the opening without skittering off into wherever the wire had gone? He submitted the question to the mechanical lobes of his collective brain. They replied that passage through the screen involved a dimensional deflection. And the velocity of light was the unattainable limit for the deflection process.

Two operators were coming toward him. He pretended not to see them and returned to the adjoining vault.

"Comrade MacDonney!" one of them called.

"Just a minute," he snapped, as he passed through the doorway.

"But something's wrong with the controls!"

"Well—come on in here!" He moved toward a rack of blank memory units. They drew up behind him, and he saw that one of them was the pale fanatic who had challenged him before Barlov.

"One of the controls is—"

"I know it!" he barked. "I'm working on it. Here—*you*—keep this unit tilted for me slightly, like this. And *you*, hold this one."

The operators obeyed reluctantly. Scotty searched through his pockets. "Forgot my test prods," he muttered. He went back to the main vault, then pressed the switch that slid a thick steel hatch over the doorway.

He heard a muffled cry from behind it. Evidently sound waves couldn't pass through the membrane and remain in space time. One of the operators was pounding on the hatch, but the thick steel deadened the sound. Scotty walked to the circular opening. One of the men approached it from the other side, saw the American, shouted inaudibly, then lunged toward him. He struck the invisible screen, then broke through. Or, rather, the screen seemed to catch him and slip him sideways out of existence.

The man at the hatch had seen his comrade disappear through the opening. He, too, bounded toward it. And then there were none.

But three others were crossing the floor of the main vault. They walked fast and stared angrily. A guard followed with Tommy gun half unslung from his shoulder.

"Why did you lock Litkin and Frei in the vault?" one of them snarled. "Open the hatch!"

Scotty gave them a scornful glance, opened the steel door, and stepped through it. They were close on his heels.

"You don't see them, do you?" he asked.

The men began moving among the aisles between the memory units.

"I saw Litkin through that hole in the wall," one of them called to another. "Then it looked like a lifting hook caught him and jerked him out of sight." They turned to stare at the wall above the opening.

The reliability of eye-witnesses, Scotty chuckled to himself. The man saw something he couldn't understand, so he invented an understandable phenomenon—and believed it.

The guard remained by the door with his weapon at port-arms. Scotty couldn't chance slamming the hatch again. He turned his total mind again toward the nature of the membrane, and calculated the power required to stretch it out still further.

The concrete partition was a straight wall that ran a hundred yards north and became one side of the corridor. The only other doorways were to the elevator shafts. No one dared enter the elevators from the corridor because of the Staff order against leaving the vaults.

Scotty turned his mind to the task of spreading out the screen. It necessitated cutting off several of the effector units to keep from overloading the main breakers. But when it was accomplished, the membrane had become a thickless disk that sliced down through the partition and blocked all doorways. He was going to cut on the analyzer's alarm system, and if guards came down the elevator shafts, they would pass through the screen in the direction of no return.

The analyzer told him that it was theoretically possible to return from



that direction—but it was very clear that the two operators hadn't done so.

The men had finished their search. They returned with baffled expressions.

"Where are they, Yankee?" one of them snapped. He seized Scotty's shirt-front and shook him roughly.

Scotty closed his eyes and concentrated.

An alarm bell thundered from just above the doorway. Red filters slid over the ceiling fixtures, bathing the vault in bloody light. The man released him.

"Sabotage warning!" someone bellowed.

They plunged toward the doorway. And met the elastic plane. And fell through. Scotty caught at the

guard's weapon as he slipped into the invisible. The tip of the barrel was already in the screen, and the gun twisted in his hands. He put both feet against either side of the door and tugged furiously. It came free with a snap. Scotty groaned and tested a bruised hip for possible fracture. Then he noticed the tip of the barrel. It glowed with a dull red heat. The reason for the men's failure to return became clear. Weather beyond the west side of the warp was rather torrid.

The two men who remained in the main vault came into view beyond the doorway. They were shouting at one another excitedly and peering behind panels for the cause of the alarm. Then they ran toward Scotty, saw the machine gun, and stopped.

One of them—the other guard—

raised his weapon. Scotty started to throw himself aside, then paused, remembering the screen. He grinned arrogantly and swung the tommy gun toward them, but did not fire.

The guard shouted something inaudible, then unleashed a bright soundless burst of explosions. The membrane seemed to shiver slightly, but Scotty felt nothing. The guard hesitated, then emptied his cartridge-drum at the American who had obviously stolen his comrade's weapon.

He dropped the tommy gun and stood in dazed amazement. The American was rising to his feet, still unharmed, still grinning. The two men bolted.

Scotty cut off the energy flow that kept the membrane stretched in the distended condition. Then he stepped into the main vault. The men were plunging toward the corridor. He cut them down with two quick bursts. He couldn't be bothered with prisoners.

The corridor guards returned his fire. Chipped concrete stung his face, and a slug tore through his thigh. He flung himself sideways as he fell, and crawled behind a panel. He heard the sound of their boots as they raced toward him. There was but one thing to do. He spread out the membrane again across the opening.

Then he dragged himself through it—in the direction that the wire had gone. It warped inward as he pushed against it, then snapped back behind him. There was a sudden spinning sensation, as if he were

riding on a gyrating top that had been kicked sideways.

Then he was rolling across hard surface. He sat up in cool darkness. He tried to let his eyes adjust, but there was a complete absence of light. He felt about him. Nothing but the hard surface. It was rough and flat, like the worn rock of a creek bed. And it was damp, sticky-damp. His own blood.

He took off his belt and made a tourniquet for his leg. The bullet had torn the quadriceps muscles, but he could still hobble on the leg.

A faint glow of light appeared then disappeared. He watched its source. After a moment it recurred. It had the shape of a human palm. Then there were two of them.

Slowly he realized what was happening. The guards hadn't seen him go through the opening. They were searching about cautiously through the vaults, wary lest he fire from ambush. One of them had undoubtedly stolen toward the opening, hazarded a glance through it, then started to slip quietly through—and discovered the screen. Now he was examining it with his hands.

The analyzer had become such an integral part of Scotty's mind that it required several moments for him to sense that he was still thinking with it. Evidently it didn't matter where he was, nor in what universe, as long as the twin consciousnesses remained identical. The transor was a mathematical expression, and if X equaled X , the expression was an identity, and the X 's were one and

the same. The location of the material quantities they described wouldn't matter.

This train of logic required only a fraction of a second, but he saw that the guard was pressing harder against the membrane. The luminous hand glowed more brightly. In a moment he would be through it.

Scotty let it collapse quickly into a point, then spread it out again. The hand had disappeared. The guard had fallen through the opening into the next vault. And if he tried to go back through it in the opposite direction, he would find himself in a warmer climate. Scotty let the membrane keep distending until it once more covered the door to the elevator shaft.

Somewhere in the surrounding blackness, he knew that the being—who-had-crouched in the corner was lurking, perhaps watching him. But he couldn't go back to the vault until its other occupants had been disposed of. He had counted four corridor guards, racing toward him. Three of them were still prowling about among the panels. If they tried to pass the membrane, he could shrink it and dump them into the memory vault from which they could escape only into the place of no return. But until then, he had to remain in the world of the unknown being.

He cursed himself for not providing Izzard with photoelectric eyes so that the analyzer could see inside the vault. He remembered Izzy's oper-

ating query—"Is it advantageous for all organisms to have eyes?" He had imagined — anthropomorphically — that it had been the wistful expression of a desire. Now he knew that it had come from her sixth occupant, who had probably been hiding there all along, providing her with the advanced mathematical concepts.

Scotty had the uneasy feeling that he wasn't altogether the guiding mind behind all that had happened since Izzy had first come alive. But there wasn't any way to check the theory: the being had erased many memories before it departed. It seemed to be using him indirectly, leaving him only such hints as he absolutely needed to accomplish his task.

He turned his attention suddenly to the robot missiles which were ready for launching at the Siberian blast-off site. One of them had suddenly stopped sending in the pulses. Somebody had cut it off! The General Staff had undoubtedly radio-gramed the station that something was wrong with the analyzer.

Scotty began concentrating on the missile-guiding unit. He sent a wave of blast-off pulses, then waited for the reply that the rockets were airborne. Two hundred and forty-eight signals came back with course, altitude, speed, and angle of climb. Another signal reported rocket-failure. The missile was still grounded. He gave it a selective fusing order, then detonated it. Another of his circuits immediately picked up its explosive pulse.

That took care of the launching site. The communications equipment would probably be close enough to the flight-line to be destroyed. If personnel were still alive on the base, they wouldn't be able to report what had happened. Seismograph units and neighboring towns would report the explosion, but until someone went out to look at the site, they would probably blame it on an American raid.

He then deployed the missiles and put them into a one hundred and eighty degree turn. When they completed it, he set them to home on his own signal and brought them down to skim along, at a few feet above the ground, so that radar locating equipment couldn't spot them. He circuited the missile-unit out of his conscious mind and left it to its own devices. It became like the breathing of his lungs, normally unconscious, but quickly switching to the conscious level in the event of trouble.

Suddenly, from out of the darkness overhead, a scream rang out. Then a body thudded on the rock surface. He started in surprise, then remembered that the membrane also would be covering the elevator entrances on two higher levels. Someone had entered the shaft from above, and fallen sixty feet down on Scotty's side of the screen.

A faint groan came to his ears. It seemed faraway. The body would have fallen about a hundred yards from his own location. He struck a

match and peered through the gloom, but the dim flicker illuminated only a small area of the rough rock surface. Whoever the man was, he was an enemy, and Scotty decided not to approach him. He would hardly walk away from a sixty-foot fall.

The match flickered out, but it had lasted long enough to show him evidence of life. There were patches of gray-green moss on the rock, and a wandering tendril of creeping vine. But no animal sounds had pierced the stillness.

He stood up painfully. The leg had gone numb. He loosened the tourniquet slightly, but the bleeding began again. He tightened the belt and hopped toward the place where the luminous hands had appeared.

Since they had appeared but once, he reasoned that the remaining guards had seen what happened to their comrade when he tampered with the membrane. Scotty tried to size up the resistance he would meet when he stepped back through the screen.

First of all, the order to stay in the vaults would be countermanded by now. But he knew that no one had entered the elevators on the vault level, because they would have been hurled into the dark world wherein he had his present being. And he had heard no one except the falling body. The falling body told him that one of the elevators had been on the higher level. The fact that no one had entered his universe on the vault level told him that *both*

lifts were on a higher level. And they must be staying there.

Why?

Because when a passenger had disappeared, the operator would have leaped through the wrong side of the membrane. And both elevators must be at the top level because a large party of men was trying to enter the vaults.

Scotty decided to have a look at the body before he went back. He touched the membrane and began making his way along it, striking matches at regular intervals. At last he saw the motionless figure—and went to bend over it.

The man was Varnoff. His back was broken, but his lids were parted, and his eyes glittered in the match light.

"Ah," he whispered, "Comrade MacDonney, I . . . never had . . . chance to . . . thank yot. We found . . . Porshkin was real . . . leader of underground."

Scotty gasped. "You're lying, Varnoff!" he barked.

"No, I—" Varnoff hesitated. He seemed suddenly to understand that something was wrong. He began moving his arms weakly and trying to turn his head. "The marshal . . . where is . . . is . . . is he all right? Didn't fall—"

Suddenly the commissioner's head lolled sideways, and he sagged limply. Scotty left him for dead or unconscious, and went back to the screen. He made his way weakly toward its center.

Porshkin the leader of the underground! Scotty had destroyed him. The knowledge made his misery complete. He had betrayed his country. He had been responsible for the success of the terrible bombings. He had built the machine that killed his wife and children. And even though he had restored them, they were but fleshless circuits in a perishable machine.

He felt Nora's protesting thoughts—and for a moment he confused them with her physical voice. He seemed to hear her with his ears as well as his mind, but of course, he had become accustomed to the analyzer's extra senses. And her thought lasted only an instant. It had been choked off.

He traced circuits to find out why. And he discovered that the sixth being had returned, as if to clap a hand over her mouth. Scotty felt a tingle of anger. The being seemed able to come and go at will—without the necessity of transor-searching.

The being replied to his anger by circuiting a memory at him—a very recent memory. Varnoff's last words. *About—the marshal!*

Scotty got the hint at last. "The marshal!" could mean only one person—and Varnoff had been worried about his falling. Falling as Varnoff had done, and from the same place. Evidently the premier and other officials had already been assembled on one of the upper levels when the trouble began. The membrane had blocked them off, and prevented their descending to the vault and

their returning to the surface. They were sealed in on the second or third levels. Varnoff, having the lowest rank, had been invited to stick his neck through the screen.

Scotty had found the center of the screen again. He started to step through—then remembered that a guard might be covering it. So he set off the alarm to distract attention, then leaped.

The top spun and was kicked aside. Scotty found himself rolling across concrete floor under blinding lights. He crashed to a stop against a panel, and expected to feel slugs tearing his flesh.

But the vault was empty. He sat up, blinking. What had happened to them? If they had passed the barrier in his direction, he would surely have heard them in the darkness.

The sixth being allowed a thought to pass to him: "The gate is the doorway to your own transor region. It matters not how you enter. Yours led to darkness."

"Then the guards went through to no-return?"

But the being would not answer. Scotty sat puzzling over it for a moment. His own led to darkness. It did indeed—to the darkness of shame and doubt and remorse.

"Don't, Scotty," Nora thought. "You can make the sun rise—" Suddenly she was cut off.

Then with horror he realized that her transor pattern was being taken out of the analyzer—by the sixth being. Scotty's mind leaped into action. He fought against the process

with every circuit at his disposal. His physical body broke into an icy sweat as he wrestled with the thing. But it beat him down, walled him off, and left him clinging only to the basic circuits necessary to the form of his transor. Then the being's words thundered through the analyzer.

"Fool! Do you think their patterns are destroyed because the mold is shattered?"

Scotty slumped slightly. They were all gone, Nora, the children, Izzy. Sure, they could be set up again, if the thing who was now in command allowed it.

"Why did you do it?" he asked. But the being had fallen silent again behind the shroud. It had released the units again to Scotty.

The missile unit was nagging at him. He circuiting it into unconsciousness. There were now only one hundred and eighty units in his control. The other sixty-eight were off course. He could "hear" their reports, but somehow his commands were not reaching them.

Then he felt a crude, shapeless spurt of charge in his control circuits. It was as if someone had touched a screwdriver across a pair of bare wires. He tested the remote leads to the transmitter station.

Someone had cut into the cables that led out of the city! Someone had set up a makeshift keying arrangement. Scotty knew that they could never take orderly control of the rockets, but they could easily bump them off course. He paused

to analyze the situation.

The bundle of cables that ran to the station was a massive tangle of several hundred wires. Whoever was tampering with it had thus far succeeded in isolating only one unit. He must act before they found the others.

First, he increased the velocity of the remaining robots. They were about twenty minutes from the city. Then he readjusted their courses so that they would strike their target without further external control. Having done this, he cut off the transmitters, swept them off frequency, and changed the signaling interval. By the time the tamperers figured it out and made readjustments at the station, it would be too late.

A signal bell jangled from across the vault. It was the direct phone to the transmitter station. Scotty smiled grimly as he went to answer it.

It was Barlov. "What kind of deal do you want, MacDonney?" he snapped.

"No deal, Shorty!"

"Listen, man!" Barlov fumed. "You can't blow a cityful of civilians off the map! It wouldn't change anything anyway!"

"Except that the central government would be gone, and the people would revolt. You know your chiefs of state are trapped down here, don't you?"

"I've contacted them by telephone, yes! But that doesn't mat-

ter. They're just as expendable as anyone else."

"O.K., then we'll expend them. You too. Start running, Barlov. If you can move about thirty miles in the next ten minutes, you might get away from the blast area. The way they're coming now, the bomb pattern will extend out to about forty miles from the center of the city—one bomb about five or six miles from the next one, over the whole area. Lord knows where those you bumped off-course will go! Not far, though. Maybe you'll meet them."

Barlov wavered. "What is it you want, MacDonney?" he asked.

"Give me back that transmitter! Then I'll hold off the bombs until your men make some circuit corrections for me. After that, we'll discuss it again. If you co-operate, no one will be killed."

"What circuit corrections?"

"Give me the transmitter first!"

There was a long pause. Then Scotty felt the jumpers being pulled from his control circuits. He took a moment to regain control of the fleet, then set them in a circle about the city.

"That's fine, Shorty," he said. "Now make the following connections at the terminal panel: point A-10 to point J-17, point R-42 to—" Scotty read off a list of several connections and disconnections.

"What'll that do?" Barlov grunted.

"Stop asking questions! I'm getting impatient. When those missiles

start running low on fuel, I'll bring them in!"

"O.K., hold it!"

There was a short pause. Then Scotty felt his instructions being carried out. Immediately he brought the robots in closer to the city, unfused them temporarily, cut the jets, spun them in tail first, then fired the jets again. The circuits wailed off a fast and erratic deceleration. It was by no means a landing, but only a limited crash.

The vault trembled as if from an earthquake. Scotty cursed. Several of the missiles had exploded accidentally. Barlov was shrieking gibberish into the telephone.

Scotty felt the membrane pulsing. Evidently the occupants of the upper level were leaping through it in their hysteria.

He shouted Barlov down, then said, "Those explosions weren't intentional, but it's a good demonstration. There's over two hundred of them left, scattered over the city. Now I'll explain the circuit changes you made for me." Scotty refused the remaining bombs as he spoke. "The whole business is now set to detonate if the transmitters stop sending out the signals, or if anybody tampers with the bombs."

Barlov began cursing him softly. "I trust you'll provide me with a good maintenance crew," Scotty continued, "to see that the station is kept shipshape. And you better bring in all available troops to keep people away from the missiles."

"And don't try to evacuate the

city," he added, "or I'll touch it off."

He hung up, then turned his attention to the semantics circuits. The sixth being had been doing something to the unit while his thoughts were diverted.

"Hello, Mr. Godmaker," said a sneering "voice."

"Porshkin!"

"So, the traitor has turned patriot again, eh? I, Porshkin, the materialist did predict it."

The percept of bellowing laughter came from the bodiless bear. Scotty stood stricken.

"You are stupid!" Porshkin roared. "I see you still are thinking that I am one of *them!* Look, fool! Look at my mind! And see why I wanted you to fail, and why the assassin knew where and when to find you! Look! I open myself to you!"

The Russian dropped his electrical cloak. But the sixth being stepped in to choke off some of the circuits between them. But Scotty saw enough, enough to believe what Varneff had told him. Porshkin had indeed been the leader of the underground. He had hoped that the General Staff would count too strongly on Izzard's abilities, and that they would delay the invasion, and that Scotty's final failure would give the Americans time to prepare.

And he saw the depth and the intensity of Porshkin's mentality, his seething inner fires. The man was unchainable. He was no fanatic, either for the party or against it. He

was simply the personification of individual freedom, the image of the thirst to shed all shackles. He could never be anything except an uncaged bear, an angry destroyer who tried to wreck whatever threatened human liberty—be it man or be it nation. Scotty felt suddenly humble and impotent before him.

Porshkin seemed to catch his sentiments. "Bah!" he snorted gruffly. "You are a man of intellect, Mr. Godmaker. And because you are a specialist, you are a fool in many things. They fooled you so easily with the movies. You use all your mind to think with, and you have none of it left to guide your emotions with. Bah! You are like a credulous, sulking child, with the brain of a genius."

Scotty stood up under the inquisition because he knew that he deserved it.

"Look toward your so-called membrane!" Porshkin snapped.

Scotty looked toward the opening. Suddenly something burst through it and came tumbling across the floor. It sat up.

It was Porshkin, the man.

He smiled the red smile in the black brush. "Where did you think all that energy was going to?" he snorted.

Scotty gasped.

"When you set a transor in the machine, you do something else on the other side," the bear explained. He stood up. "Now let's get to work and build ourselves some arms and legs, comrade."

"Do what?"

"Arms," Porshkin roared, "with fists attached! You know! Tanks, planes, new weapons! You've got the whole crew of engineers and workers trapped in the city. We'll activate every robot device in the area, and put controls on the rest. The 'brains' got to have muscles, boy! We're in command of a city, but not a country. And after they get another provision government set up, we won't even have the city! We've got to work!"

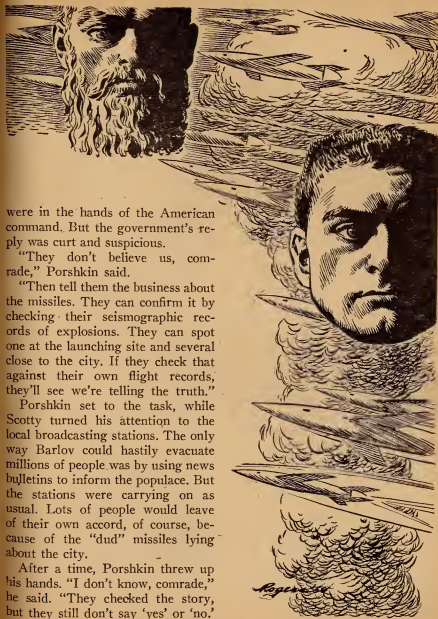
"Listen," Scotty said thoughtfully. "If you can prove your identity to the American government, maybe there's an easier way."

"Yeah! The underground code. Varnoff never got his hands on it."

"All right," Scotty said. "Get on the radio. They won't believe *me*, but you can give them the situation." He gestured toward the strategy unit. "The operators left their tapes. They've got all the information about the whole war setup on them. Troop locations and concentrations, air strength, data and statistics on everything from the front lines back to the factories. Give them all the information, then run it through the strategy unit and send them a master plan. If they strike now, while we've got the country's brains paralyzed, it'll be like—"

"Like beating up a blind-man," Porshkin howled gleefully. "Let's go!"

In a few hours, the thing was done. The statistics and the plan



were in the hands of the American command. But the government's reply was curt and suspicious.

"They don't believe us, comrade," Porshkin said.

"Then tell them the business about the missiles. They can confirm it by checking their seismographic records of explosions. They can spot one at the launching site and several close to the city. If they check that against their own flight records, they'll see we're telling the truth."

Porshkin set to the task, while Scotty turned his attention to the local broadcasting stations. The only way Barlov could hastily evacuate millions of people was by using news bulletins to inform the populace. But the stations were carrying on as usual. Lots of people would leave of their own accord, of course, because of the "dud" missiles lying about the city.

After a time, Porshkin threw up his hands. "I don't know, comrade," he said. "They checked the story, but they still don't say 'yes' or 'no.'"

They just keep on asking silly questions. They thought I was dead."

"What about your underground?" Scotty asked. "Have they got transmitters?"

The Bear nodded. "Yeah, they could—" He paused.

Scotty groaned. "They think you're dead too, though," he said dismally.

Porshkin laughed. "Hah! How they think I'm dead? Only way they knew me was by code. Da, Da! I can call Rizkin and have him contact American agents. They'll believe *him*." He began retuning one of the small local transmitters.

Then a light on one of the receivers began blinking. Scotty brought its output into consciousness. At first there was only the faint hiss of a carrier wave. Then a voice broke through. It was Barlov.

"All right," MacDonney," he said. "Detonate the bombs, if you want to. I'm in a transport plane a hundred and fifty miles south of the city. And with me, I've got every man who's of any importance to the people's state—except the ones you've trapped, of course. As I said, they're expendable. Even the marshal's only a symbol."

"And you'll be the new symbol, I suppose," Scotty replied, as he set up circuits to take a fix on the aircraft.

"Certainly, certainly!" Barlov called.

Scotty led him on until he had a

fix. Then he swept through all possible robot frequencies until he found a positioning pulse. At a base in the Ukraine, a ground crew was running a routine inspection on a guided missile. It's "climb angle" showed that it was on a launching rack. Scotty sent it a blast-off signal. Then he directed it toward the fix. In half an hour, its own radar found Barlov's plane. Scotty sent it to home on the ship, and fixed its detonator for an explosion at two thousand feet from the target. It would give Barlov a fraction of a second to suffer before he charred and melted.

Porshkin was finished. "Rizkin has contacted the agents," he said. "Now we wait and see."

They listened on the American tactical frequencies. They were becoming jammed with coded messages. Scotty "memorized" several minutes of the jumbled letter-groups. Then he put the math and semantics units to work. Soon the message was decoded.

"... immediately. Task force nine to be sent against point seven-eight-zero. Dispatch units 6-AX-7 toward Vladivostok area—"

It was part of the strategic plan.

Porshkin smiled slowly. "Without a government and without a high command, the Russians will wither." Then he laughed his roaring laugh and patted the panel of the machine. "Meet the new Czar, boy!" he bellowed.

"It's your baby, now, Porshkin," Scotty told him sadly. "When the

Americans get here, I may be hung."

"Why? You didn't *start* the war. And most of the raids on your country were accomplished before the analyzer was set up. It was only operating for a couple of weeks. So half a dozen cities *were* destroyed. They'd have been bombed anyway. And it's a cheap price for winning the war."

Scotty shook his head. "It wasn't my business to *set* the price," he said. "No, Porshkin, I broke faith. Whether they call me a traitor or a patriot—it doesn't matter. I can judge myself; and I find myself guilty."

"*Silence, Man!*" roared the sixth being. "It is *I* who judge!"

A twisting force seemed to grip Scotty's mind. He slumped heavily to the floor. The very warp and woof of his existence seemed to be wrung between mighty hands. The being was doing something to his consciousness circuits—and to *him!*

Then he was suddenly somehow beyond the membrane. But it was no longer a place of darkness. A bright sun shone in the sky. The rock was a broad, flat ledge atop a mountain. Below him, a land of forests and lakes spread out toward the horizon. He groped back toward the screen in terror. Just as he spun back through it, he caught a glimpse of someone else on the rock—someone familiar, but not quite discernible in the distance.

Then he was rolling across the

vault floor again. He looked around. Porshkin was bending over a body—Scotty's body. It had dried blood on its leg.

Scotty looked down at himself. There was no wound in his new leg. But he could see through it hazily.

A kind of impatient sigh seemed to come from the sixth being. Then Scotty found himself tumbling back toward the membrane again. When he bounced heavily on the rough rock of the mountain top, there was the after-sensation that he had been chucked through by the seat of his pants. He felt for the membrane, but the being had collapsed it. It was gone.

Still he felt the remnants of his circuits in the analyzer. And the being parted the shroud of secrecy slightly.

"You have restored yourself," said the voice. "You have lost one world, but gained another. And, my young friend of a young race, do not make the mistake of believing that yours is the first people of the total continuum to achieve understanding. The first to conceive and build mechanisms to extend the mind.

"And do not believe again that physical-material transit—limited in speed—is the sole road of exploration.

"You have a new world. The feeble energy sources of your machine could not supply energy for more than a single physical totality transor; Porshkin is more needed in the old world. You are more needed in this."

Then Spotty's consciousness circuits were scraped out of the machine like scales off a fish—leaving him but the brain and the body of a man.

He heard footsteps on the rock nearby, then a familiar voice.

"Scotty-Mack!"

Her face was cool from the mountain breezes as he pressed it against his own, and the wind whipped her ashen hair about his cheeks as he

kissed her. But smaller hands tugged at his legs.

"Hi, kids!"

After a while they went to the edge of the ledge and looked at the broad green panorama, empty of civilization.

"No people," he murmured.

Then he saw her faint smirk. He got the point. The Being had also spoken to *her*—about increasing and multiplying.

THE END

BACK ISSUES

The little ad about back issues we ran in the February 1951 issue produced a flood of demand that swamped us. I didn't expect action like that! However, for the future: as a convenience to readers, we stock some back issues. At present, practically everything earlier than 1946 is gone. Later issues are available. The prices: Up to one year old, 25c. From one to three-years old, 50c. Over three years old, 75c. Back issues are not our business; the increase is to cover storage and handling costs; the copies are new stock that has been stored, not used copies.

The Editor.



GUESS AGAIN

BY J. A. MEYER

Of course, a girl's guess, based on an unprovable psychic "hunch" ability, meant nothing beside the precise mathematics of physical science —

Illustrated by Cartier

"But how did you know I'd be here, Jean? I always eat at the lab, now."

The girl looked up suddenly at him, and shrugged. "Hunch," she said. "I just had a feeling you'd get the afternoon off."

"Oh," Bill said, "one of those

again, huh?" She nodded, while his fingers drummed on the luncheonette table.

"Well, go ahead and tell me," Jean said, "before you explode."

Bill grinned at her, and stirred his coffee. "We finished it—the Fenton-Tube linear accelerator. Har-

ley even said that six-phase magnetic deflector . . . I didn't tell him it was your idea . . . was the—"

"It did work, then?"

"Yeah, listen to this now. We're going to start Test A tomorrow, on the mean square variation, for the overmax—"

"Overmax?"

"Yeah, Jean, when we get that synchrotron working, we'll have those electrons moving at 99.998 max—that's light-speed—and then we deflect them into the Fenton Tube, and really give them a shove."

"You lost me way back there," Jean said.

"Sometimes, Jean, I wish you knew more about my line of work than you do. It's peculiar the way you just come out with words, or ideas—and don't know what they mean."

"Hm-m-m. Well, they're usually something about your work, and you come home in a couple of days, and tell me what they mean. Finish your coffee Bill, before it gets cold."

Bill nodded, and started to drink.

"But guess who Harley put in charge of—" Bill began but noticed that Jean wasn't listening, day-dreaming very quietly, making funny scribbles with her fork on the tablecloth. "Jean."

She stared silently at her plate, doodling with the fork, then looked up suddenly. "What's a Harris-Nevin Effect?" she asked.

"Who told you about that?"

The girl shrugged. "Oh, just an

idea that hit me. You know. Why?"

"It's a mathematical development of threshold accelerations. Quantum probability with variants. It's one of the—"

"You know I don't understand a word you're saying," she interrupted. "Harris-Nevin just popped into my head."

"Yeah, but those hunches of yours are sure convenient sometimes."

Jean had that peculiar knack of guessing the order of a carefully shuffled deck of cards—before they were shuffled. Precognition, the psychologists called it, and when they tested her, they found she scored about two hundred per cent better than chance.

Nobody, not even Jean, knew she had it for a long time. She didn't recognize the flashes as anything unusual, and never mentioned them. She played cards and chess carelessly, and never lost. She went through high school in a breeze, somehow always managing to study exactly the right things before tests.

"I guess I'm just lucky," she said.

With her high school record, a scholarship to college was inevitable. One day in her freshman Psychology class they had a little discussion of psychic phenomena. The professor to live up the course, tried a little trick about guessing the denomination of cards—

The Psychology Department came up with some pretty clever tests for her after that. When they were a

few weeks into the program, they knew they had the real thing on their hands.

Jean wasn't much impressed by their results. She knew it wasn't entirely luck, but didn't think it really amounted to much, except that she lost interest in playing cards. It was too easy to win. And she began to wonder if her high marks and high I.Q. weren't entirely due to pre-guessing the tests.

"At least I can make a living playing the horses," she laughed. The frequent tests in the Psychology Department, playing those card games, and rolling dice in closed boxes, rearranged her schedule, and she became a fairly steady patron of a local luncheonette.

That was where she met Bill. She learned he was a grad student in Physics, working for his Ph.D., and she told him a little about herself. He was so wrapped up in his own work, though, that he didn't pay much attention to "that Psych stuff."

One day she asked him about something he was working on, and he couldn't make head or tail out of what she was saying. She didn't understand it either, and they forgot about it temporarily.

The next evening he reminded her about it. What she had been talking about was a result from an experiment he didn't get until the next day. That was the first time she realized that those "hunches" of hers might apply to other things than cards and dice.

They gradually developed a tech-

nique, where Bill would talk over his lab work with her, and the tests he was making, and so forth. She didn't understand it too well, even though he tried to show her the math and principles involved, but she could still pre-guess his results amazingly. Knowing what to look for, his progress was phenomenal. He told her once, jokingly, that they ought to get together.

After he got his assistant professorship, during her sophomore year, he said the same thing, not kidding. They got married the next Sunday.

The "hunches" kept coming every once in a while. Jean didn't always know what she was talking about, because they came sometimes as words, sometimes as pictures that just flashed into her mind. She picked up the knack of spot-memorizing the words and formulas and copying them down so Bill could study them.

"If I keep this up," she told him, "I'll get a day ahead of myself."

Most of the hunches were inaccurate, but now and then she rang the bell. She could usually tell the right ones, too, when they came. They were more vivid and persistent than the others.

She was in her Junior Year then, and taking evening art courses besides, partly because she wanted to hold those occasional visual "flashes," and partly to take up the time because Bill was working late every night at the big synchrotron lab. She cut her midday classes one

day, and "ran into" him at the luncheonette. He was bubbling over with news of a promotion. He was being made director of a test phase of the synchrotron project.

While he was telling her about it, she had a funny hunch about a "Harris-Nevin Effect"—

"How about coming down to the lab tomorrow, Jean?" Bill asked one night about a month later.

"Sure, Bill."

She didn't ask why, but he explained. "Harley began wondering how I was pushing the project so fast. We didn't have many of the usual experimental lags, you know. So I told him about you."

"And?"

"He said he wanted to see you. He checked Psych about you, but he's a kind of skeptical character. We're going to be pushing those sub-particles up to critical tomorrow, and Harley wants to see if you can guess which of the Harris-Nevin variables we'll get."

"I'll take a cab over in the afternoon, O.K.? You can have me cleared with the gate by then." Bill nodded, and downed his coffee.

That night she woke up screaming from a nightmare. Bill tucked her in again, and told her to go back to sleep. But, although she stayed wide-awake half the night, she couldn't remember the last detail of what woke her.

"This is the sweat shop," Bill said, when she finally got to the lab.

The synchrotron was immense, bigger than she had imagined—a concrete ring two hundred feet across—and in the middle of the "doughnut," were countless computing machines and miles of wiring and magnet terminals. Outside, the Fenton Tube linear-accelerator was a long concrete tunnel, tangent to the synchrotron.

The machinery hummed loudly, and there was an occasional crackle of current. She guessed that Harley was the lean white-haired man standing in the middle of the lab, snapping orders at the younger men. Everyone seemed frantically busy, as she walked through the banks of wiring and generators. Harley didn't notice her until she was only a few feet away. Then he turned quickly.

"Is this the soothsayer?" he asked.

"This is my wife, Professor Harley."

Harley shook her hand, and said "delighted" like he was swallowing poison. Then he asked her what she thought was going to happen.

"We expect to push the electrons across the barrier—"

"Barrier?" Jean asked.

"The Einstein limiting velocity concept—an antique notion. Of course, according to *his* theory there's some possibility of a total matter conversion, but by our calculations *we* expect one of the Harris-Nevin particle conversion chains—"

"I'm afraid I don't follow you," Jean said.

"My wife never studied any of the physical sciences," Bill explained.

Harley shrugged. "As I suspected. I don't suppose," he said, turning on her, "you could *tell* us which of the H-N variables we're going to get?"

Bill looked at her hopelessly.

"Could I watch the machine for a while?" she asked.

"If you think it will make any difference."

She sat there for about an hour, chatting with some of the profs and grads who weren't busy, while Harley stalked around the lab, bristling.

"Don't mind him," they said, "he's like that all the time. Wants to see his name in lights—"

Her face went white suddenly.

"What is it, Jean?" Bill asked.

Her mouth slowly closed. "Turn it off!" she said in a choking whisper. "Turn it off!" She started to scream hysterically. Bill's hand clamped over her mouth, and he pulled her aside. Everyone stood there watching tensely, except Harley, who sniffed annoyedly, and turned to watch the instrument board. Jean stood there crying and shaking for a while.

"What was it, Jean?" Bill asked again.

Her voice was a frightened whimper. "It was . . . just like that dream. Lights, bright burning lights, and . . . then everything went . . . empty . . . gone." Bill whistled softly, and one of the grad students coughed stranglingly.

"Maybe I'm *wrong*," she said.

THE END

IN TIMES TO COME

When a prophet scores one hundred per cent, it is generally believed that he has, somehow, been stacking the cards—but even with a free hand to stack the cards—or select the stories—I can't score one hundred per cent on prophecy. "Breeds There A Man," by Isaac Asimov, scheduled for this issue, will be (we hope!) in the *next* issue.

Fitting a magazine together involves a sort of jigsaw-puzzle job. Of course, it's always possible to use the Procrustian Bed Technique, but as ASF's authors will testify, we don't go in for carving out pieces of stories to make them fit.

The cover story we usually do get in, so you can be fairly sure of . . . And Then There Were None," by Eric Frank Russell. Has to do with a world where you couldn't buy anything, and the only way you could be a miser was to go out and keep doing things for your neighbors for nothing!

THE EDITOR.



BY H. B. FYFE

ASTOUNDING SCIENCE-FICTION

KEY DECISION

To win the position of Galactic Co-ordinator in a competitive, democratic Empire, a man must be hard and strong and fast in his decisions. But the hardest decision of all . . . ? What would it be?

Illustrated by Cartier

They came for Kelvin Crayn in the middle of the sleeping period on Beta Sagittarius IV. Taut from constant anticipation, he jerked nervously to a sitting position in bed as the door of his chamber crashed open. In the group of uniformed men shoving through the portal, he recognized Lieutenant Marshal Mulok.

The latter, resplendent in the diamond-crusted braid of Galactic Headquarters, stepped forward stiffly. His blunt features were frozen into an expression of such infinite respect that Crayn hardly needed to voice his question.

"The Advisor?" he whispered.

Mulok nodded gravely.

"A few minutes ago. The Galaxy is in your charge!"

Crayn inclined his head silently. The statement was slightly grandiose, he told himself. Only about fifty percent of the stars had been found to have inhabitable planets; and only three quarters were con-

trolled by the Galactic Union.

Most intelligent beings, humanoid or otherwise, were members or allies of the Union; but the Survs and their confederates were still a menace. Despite these halogen breathers, however, three quarters of the galaxy was a proud empire—one to make a man measure himself and his preparation to direct it.

The new Advisor beckoned to the group in the doorway. A general scurried forward.

"Have the Advisory Board informed," ordered Crayn, "and request Gax Ludauk to take up residence in this building as Chief Alternate. Order the other alternates to change their headquarters according to precedence."

He waved the others after the general, who was hastening out to put the orders on the telebeam. A raised finger told his aide and Marshal Mulok to remain. Unordered, and apparently uninterested, four

hard-faced colonels took stations in corners of the room. They were heavily armed with hand-weapons that could blast through a wall. Their alert eyes roved restlessly about, occasionally flicking to the indicators of various instruments on their persons.

"What information do you have for me, marshal?" asked Crayn, as his aide brought the unworn uniform that had been prepared in anticipation of this moment.

"The former Advisor's heart failed fifteen minutes ago."

Crayn nodded. It had been expected; his predecessor had been a hundred and sixty-three, thirty-odd years older than Crayn.

"May I respectfully suggest that the Advisor consult the Galactic Staff immediately?" murmured Mulok. "His predecessor was considering reports that the Survs have found new allies."

"New allies?" exclaimed Crayn. "Wherever from?"

His impulse was to suggest propaganda, but he knew that anything reported to an Advisor must have been screened through hundreds of experts. This called for his personal attention.

"Lead the way, marshal," he said, waving back the aide and closing the last zipper himself.

One of the bodyguards wrested this precedence from the marshal. A few minutes later, they entered the second of three gravicars that immediately began the plunge through a secret shaft to the deep fortress-

palace of the galactic ruler. Crayn glanced at his finger watch as his aide fastened the cloak he had brought hurriedly after them. It was three-forty-seven, Galactic Time.

In spite of his years of training, Crayn had a feeling in his knees not unlike the day he had passed his first scholarship test as a boy—

The tests had been difficult; all the applicants were of top-level intelligence. Waiting to be interviewed and informed of his standing, Kelvin wondered if anyone would suspect that he had peeped under the carbon to see where the pencil marks were supposed to appear as he checked the answers of his choice. He felt no very deep remorse; for some of the questions, on the "stellar information" test for instance, had been so farfetched as to seem downright unfair.

"Kelvin Crayn!"

The receptionist, an excessively clipped and scrubbed young man in a uniform that emphasized his bulging muscles, jerked a thumb at the door behind him. Kelvin walked through it into the next office.

A middle-aged man, about ninety or ninety-five, sat there behind a desk. Both his uniform and the desk top were neat to the point of austerity. Frosty gray eyes swept over Kelvin, straightening him up like an electric shock.

"Crayn, K.," murmured the Galactic officer, consulting a record sheet. "I suppose you want to know how you did?"

His tone made any such curiosity seem improper—contemptible—even perverted. Kelvin swallowed and tried to moisten his lips.

"As a matter of fact, you did quite well, both in the physicals and the written tests. You were especially good on stellar information. Very few got that question about the third planet of Pollux."

Kelvin wondered if he were keeping his face straight. He did not like the trend of the conversation.

"As a matter of fact, even fewer could identify the sketches of those continents on Vega VIII. You cheated, of course?"

"I . . . uh . . . yes!" Kelvin choked miserably.

"Well, now, as a matter of fact, so did we. There are no such planets as . . . uh . . . as it happens."

He turned his frosty gaze downward to his desk, as if to enjoy the thought in solitude.

"What interests us," he continued at last, "is that you are one of the few who cheated just the proper amount, with a nice balance between daring and shrewdness."

He chuckled dryly as Kelvin stared.

"The Galactic Service needs men and non-men who can be clear-sighted enough to realize when rules or customs are obstacles of less worth than the main goal!"

The new Advisor and his little retinue left the gravicar at the bottom of the shaft. Marshal Mulok led the way toward the central confer-

ence room. The colonels regarded the empty corridor with professional suspicion, but Crayn thought of the huge information center at the other end. The name "conference room" was hardly adequate, for it was surrounded by devices and staffs organized to present a staggering amount of vital information to the Advisor's most casual glance.

They never made any attempt to describe this to us at the Academy, Crayn thought.

Cadet Crayn was assigned to the Sector Academy on the sixth planet of the star Omricon Eridani A. Sixteen lightyears from Sol was a distance great enough to break the few ties the orphaned Kelvin had had. His new post was part of a multiple star system, which made it ideal for astrogation problems and exercises. All eight planets were utilized by the Academy, for anything from growing food to staging mock battles. In regard to the latter, a student was expected to be always on the alert, whether during a "leave" of supervising a food-producing planet or when he was deliberately marooned in war maneuvers.

During the ten-year course, Cadet Crayn achieved a widely admired reputation for always landing on his feet.

"I don't know how you do it, Crayn," one of the instructors told him frankly, after an unfortunate incident during a landing problem on an especially bleak planet. "But if I had known beforehand that five of

you would crack up a jet in that canyon, I'd have bet on *you* to have the only oxygen tank full enough to let you walk out."

"I was lucky, sir," answered Crayn with a polite but reserved smile.

"Luck, eh?" The instructor, a lean, graying space-veteran stared at him shrewdly. "Well, maybe it was that and maybe it was . . . forethought, say. Whatever it might be, I'm betting it will take you far."

It had taken him far, the Advisor admitted to himself as Mulok ushered him to the chair at the head of the gleaming conference table.

A good deal of it, he admitted further, *had* been luck. He had added a blend of determination, natural brilliance, and—when necessary—a cold ruthlessness. The result was that he now prepared to grasp more power than any other living man in the galaxy.

He sat down, rested his hands on the arms of the big chair, and gazed at the charts surrounding the conference room. Some of the latter were even then being changed and brought up to date by technicians working on the other sides of the transparent walls.

No, thought Crayn in the few brief minutes it took his staff to find places around the table, *it wasn't all luck or brains either. Some of it was plain hard work and taking a chance.*

There had been the time when, as a brigadier with a few light cruisers,

he had been caught by a major Suruvian invasion fleet in the Lu-Irra system. The Galactic forces on the headquarters planet had been overrun with a rush. Crayn had faded quietly into space with his ships, apparently leaving the beautiful planet with its four small moons and a ring where there once had been a fifth completely in the hands of the Survs.

The latter had changed their minds about that, however, at least for the brief instant allowed most of them when particles of the ring began raining down to the surface. The bombardment of meteors, touched off by a planetoid Crayn had managed to send careening through the ring, pounded the greater part of the invading ships to dust and left a band of the planet as pockmarked with craters as the Luna that Crayn had known in his youth.

But ends are not always gained by direct force—

Viceroy Kelvin Crayn, having completed many tours of duty and several postgraduate intervals at high command schools, celebrated his ninetieth birthday in the system of a star named Holfad. From Sol III, Holfad's location in the constellation Scorpius was better suspected than seen. There were to be fireworks for the celebration.

The general who was his chief of staff at headquarters beneath the surface of the second moon of Holfad VII turned with a gleam of teeth as Crayn strode briskly into the central planning room.

"They come, they come!" he gurgled. "Fools! Mincemeat will try he be!"

Crayn suppressed a twinge of annoyance at the guttural speech. The general, cold-blooded and only semi-humanoid, was a tactical genius for all that. He had as much to do as Crayn with planning the trap into which the rebels' space fleet was plunging.

"Are they completely committed?" asked Crayn, indicating his approval with a faint, viceregal smile.

On one broad wall was a telescreen showing a deep-space view, obviously relayed from some scout ship hanging on the outskirts of the invading fleet. Crayn preferred the schematic diagram in colored lights, which took up the whole expanse of the front wall. Showing the positions of Holfad and its planets, the neighboring stars, and of the opposing fleets, it helped him consider the situation as a problem in tactics.

As he watched, several lights went dark and others lit up to form slightly different predicted courses for various space units.

"It certainly *looks* as if they have us," remarked Crayn ironically.

"Yes, sir," agreed the general. "Co-ordinator Lurella has reported his fleets in position. He is awaiting orders."

Crayn scanned the wall diagram. There could be no possible flaw in his plan. While the rebels—a race of humanoids from the next star system who had been turned against the Galactic Union by insidious Surv

propaganda—were now concentrating their strength on sweeping in toward the four planets held by Crayn, their own system was about to receive visitors.

Crayn had sufficient force to put up a stubborn defense, and if necessary he could retire to another system controlled by the Union. His opponents, however, would shortly have nowhere to go.

"Signal Lurella to make his presence known," he ordered.

The non-man stared at him. "But—" he began, before remembering the deference due a viceroy.

"You are thinking, I suppose," said Crayn, studying him calmly, "that the enemy will be warned. But what can they do?"

"They must surrender, or have their civilization annihilated," the general answered slowly, almost as if displeased by the prospect of immediate victory.

"Ah . . . and perhaps you think that anticlimactic, after the war of propaganda and vituperation that has been going on. You hesitate at having it over with before a single ship has been destroyed or one drop of blood shed?"

The general ruffled the scales of his purplish crest.

"When I was younger," said Crayn, not unkindly, "I, too, liked to rely upon direct force; but now I am playing for more than an immediate tactical victory. Your strategy, general, has already assured that; mine will win good will besides."

The general had been in the Serv-

ice almost as long as Crayn. He was too cynical to swallow *that* without reservations, and permitted himself to show it. Crayn chuckled.

"I must keep costs down," he explained, "if I am to get that appointment to the Headquarters Staff. I am simply making sure that we will win the peace that follows this engagement."

"Oh," said the general, relieved.

"We shall treat the rebels as pleasantly as possible. They will, by choice as much as force, become allies once more against the Survs. Not that they have any real choice, but they will be more useful if they think they have."

"I see," said the general, showing his pointed fangs in a reassured grin. "Perhaps I should send a coded message to the defense fleet, to make sure they avoid contact until the rebels hear from their home system."

"Please do," agreed Crayn. "I shall consider it a clumsy mistake if any captain launches a single missile."

The Advisor and his staff having been seated, the chief marshal in command of the conference room Intelligence appeared to report.

"As your excellencies may see upon the walls," he announced, "the recent and continuing raids in Sectors Thirty-two and Thirty-three are superficial in spite of being widespread. Information we have pieced together leads us to suspect that a number of small incidents in Sector Eighty-four are tokens of a major

attempt in that volume of space."

Crayn studied the wall charts, absorbing their tale as a chemist might read simple formulas or an athlete estimate distances, without consciously translating the process into words and numbers. He did not bother to inquire as to the evidence, reports, sifted rumors, or logical estimates that had led the chief marshal to his suspicions.

"Review for me," he ordered, "the history of that sector, and of ranking Galactic officers who have commanded there. I note, marshal, that it is at the very edge of the galaxy, so please consider that factor in your report."

He settled back to listen, his thought flicking back momentarily to the first time he had sat in this room and listened to a lecture.

It had been a brief visit for study then, and Crayn had sat almost at the foot of the table.

"All you illustrious gentlemen have demonstrated exceptional talent," said Co-ordinator Yalku, standing at the head of the table to bring his head far enough above it to look his charges in the eye.

Crayn followed the diminutive officer's glance around. His five companions were known to him by reputation. Gax Ludauk was a tall human from Procyon VI with a long-jawed, swarthy face. He had explored and conquered a previously unknown fringe of the galaxy, a ridge of stars that looked on the galactic map like a broken-off tip of a spiral arm.



Next to Ludauk sat Xarkirri, a non-man who had fought his way up to control a star-group before bringing it into the Union. Virginius Johnson was a massive, broad-featured man from Earth's earliest colonies around Alpha Centauri. Kell Jorno and Newton Li had served in sectors distant from Crayn's stations, but he had heard the names and knew they had risen above the obscurity engendered by the vastness of the Union.

"As you may have guessed," Yalku continued, "you have been picked . . . ah, *persons* for many years. You have deliberately been assigned to services more varied than average to complete what has been an extra-special education."

They smiled politely, even Xarkirri who had learned to imitate the humanoid expression for purposes of diplomacy.

"I suppose such a life can be called an education in itself," agreed Gax Ludauk.

"No, no. I meant it quite literally. We keep a file of outstanding accomplishments. Certain officers are chosen from it and given opportunities to develop their potential abilities."

Crayn permitted himself a second of self-satisfaction. This must be the preamble to announcing their appointments to the Galactic Staff.

"May we assume," he asked, "that our abilities have earned us staff positions?"

"More than that," answered Yalku. He leaned his elbows on the table and smiled at them. "Much more than that. You have been added to the panel from which is chosen the very highest officer of the Galaxy."

He smiled more broadly as he saw that he had succeeded in startling them. With all their experience of command, it took Yalku to see it, but that merely added to his enjoyment.

"Some of you have ruled groups of stars for the Union. Some, like Ludauk and Crayn, have conquered volumes of space by battle or diplomacy. You have, on a small scale, encountered every type of problem connected with the operation and government of the Galactic Union."

Crayn saw Virginius Johnson's mask of a face twitch. Gax Ludauk's eyes glittered with excitement.

"In short, illustrious gentlemen, you have entered a postgraduate phase of your education to fill the post of Advisor of the Galaxy."

When the exclamations had died away, Yalku went on to explain the technicalities.

They would have access to all information reaching Headquarters and be expected to keep abreast of latest decisions. Gradually, they would be eased into command of special sub-headquarters so scattered as to insure survival of some even in the face of the worst imaginable catastrophe.

"You are already on the list," Yalku added with an ironic grin, "so if twenty or thirty special persons

should happen to drop dead all over the galaxy tonight, one of you might be in complete charge by morning!"

While they waited for something of the sort, he told them, they would be available for special missions demanding the attention of someone empowered to speak for the Union.

The chief marshal from Intelligence completed his report and there was silence while Advisor Crayn considered.

He was inclined to agree that the outbreak of hostilities in Sector Eighty-four indicated the existence of new Surv allies. They had been weak in that part of the galaxy ever since he could remember. It was a predominantly humanoid volume of space, which included the ridge of stars brought into the Union by Gax Ludauk.

"I thought we had that sector completely mapped by now," Crayn murmured.

"We do, sir," Marshal Mulok assured him.

Others nodded assent. The Intelligence officer signaled someone on the other side of the transparent wall and held up several fingers. A new map was projected before the staff's gaze.

Crayn studied it, then asked a question.

"In the event that another segment of the spiral had drifted off beyond Ludauk's Ridge, can we predict the probable nature of intelligent life among its star systems?"

"Oh, yes, I think so," answered

the chief marshal.

He signaled again for a chart to accompany his explanation. It seemed clear, when they saw the overall pattern of life types found along that rim of the galaxy, that the inhabitants of any such hypothetical star group would very likely be humanoid and possibly related to the races of the Ludauk's Ridge group.

"I want all possible information, from Ludauk's report and subsequent ones, on legends of ancestry and creation of Ridge civilizations!" Crayn glanced around the table as he said it. "I suspect, gentlemen, that this may be a fruitful opportunity for diplomacy."

He also gave orders that would presently bring before them charts of possible and probable star-groupings derived from formations of Sector Eighty-four and neighboring regions.

Then, thought Crayn, *I'll have a better idea if such additional stars exist and have merely been overlooked amid our other troubles. I don't know where else the Survs could find new allies.*

After that, he would have to see. Any diplomacy that would be useful would probably have to be of a higher order than his last accomplishment as a staff member without his own headquarters.

That story which later got around about Crayn and the favorite mate of the humanoid emperor of the Zobian stars was not quite accurate, but Crayn could still remember the

tense minutes in that private corridor of the palace on Zobis IV.

"I assure you, young man," he repeated with outward calm, "that I know what I am doing."

The Galactic agent in the livery of a palace steward raised a finger nervously to his lips and glanced sharply along the darkened hallway. The deep purple carpeting could muffle other footsteps than their own, although all possible precautions had been taken to ensure the absence of guards from this side entrance to the emperor's harem.

"But if you had only let us disguise you!" complained the agent. "If they catch you, the Galactic envoy—"

Crayn suspected that the man was really thinking, "*When they catch you—*"

"We've been all through that," he cut the agent short. "Just get me in to see the empress. I am expected."

The agent looked doubtfully at Crayn's thinning gray hair, as if longing to remark on the folly of a man of a hundred and sixteen sneaking into a woman's jealously guarded apartment.

He scratched upon an unmarked door, however, which was opened stealthily after a long moment. Crayn heard a few murmured words. Then a woman's hand slipped into his.

He left the steward behind and allowed himself to be led along a completely dark hall, thinking that he was out of practice for this sort of thing by at least half a century.

When a curtain was suddenly drawn back, the dim light of the chamber beyond seemed harshly bright. The curtain fell into place behind him, and he faced the empress.

She was an imperial choice and entrancingly beautiful by Zobian standards—and by most others. Crayn thought, however, that her expression held a certain boredom.

"Before I express my appreciation for this moment," he murmured, "I should like to offer your imperial majesty a trifling token of gratitude."

From an inner breast pocket of his tunic he slipped a flat case. When he snapped it open, the enormous jewels of the twin bracelets seemed to brighten the room perceptibly.

I wouldn't put it past her, he thought uneasily, to have the emperor listening behind another curtain!

It was in case of such a trick that he had produced his main weapon immediately. The empress yielded to its glitter. She smiled to herself as she held out her wrist and Crayn fastened one of the bracelets about it.

He stepped back a pace, thinking he had heard a muffled sound. He thrust his hand again under his tunic, fumbled at something along his waist.

The empress seemed to stiffen slightly. The nap of the carpet around her feet writhed away in a manner reminiscent of the lines of force around a magnet. Crayn reached out and placed the second bracelet in the woman's palm, which rose nervelessly to receive it, just as the curtain

behind her was torn aside. He saw the hard faces of armed men behind the emperor's scowling features.

"So!" sneered the ruler, striding forward. "The special envoy of the Galactic Union!"

His eyes became slightly glassy as the empress, with the expression of a sleepwalker, finished fastening the mate to her own bracelet about his wrist.

"You are welcome to my palace," he finished mildly. "Guards, you may leave us!"

A few minutes later, when Crayn drew the young agent into the chamber, the emperor was still staring at them with a vague horror deep in his eyes. The "steward" stared also, as he took in the scene. Crayn opened the front of his tunic.

"Help me unstrap this thing," he said. "As soon as I show you how it works, you are going to become the power behind the Zobian throne—literally and with a high voltage!"

"I thought those jewels were too big to be real," said the agent as Crayn buckled him into the harness holding the flat control box.

The imperial rulers of four stars and thirty-one planets waited in stiff silence.

"You had better have him promote you to some post like secretary or bodyguard," advised Crayn judiciously, "so people will become accustomed to seeing you underfoot."

He regarded the scene with a glow of satisfaction that he recognized as being the reaction to the anxious moments just past.

"Keep your thoughts clean—they're no longer completely private!" was his parting advice. "Now, call in that little girl of yours to get me out of here before the new era of co-operation with the Union gets underway!"

Kelvin Crayn, Advisor of the Galaxy, sat at the head of the conference table beneath the surface of B Sagittarius IV. His expression was grim; during the past hour he had watched many scraps of information pieced together to prove the new danger was real.

In the end, a material fact satisfied them all of the accuracy of the estimates that might have theretofore seemed built upon air. There were televised photographs of the battered spaceship of strange design towed in to a Ridge planet by the fighting captain of a defense cruiser only slightly less battered. Crayn snatched a moment to glance under the table to old Yalku, but the little co-ordinator was already scribbling down the young commander's name for his special files.

Some day he might be Advisor, thought Crayn pityingly.

He sat like stone a few more moments, studying the walls about him and absorbing their data.

It was not, he told himself, that he feared to meet a crisis; but he had doubts about his fitness to handle this special problem. He knew he could fight or wield diplomacy, he had a broad understanding of the galaxy and he had learned when to use petty

treachery—all true, yet not enough.

It's a specialist's job, he thought rapidly. No time for studied analysis, even with a staff like this. It has to be someone who knows the sector like his own hand, who can even think like these new people without half trying, and pry them away from Surv influence.

He glanced at his finger watch. Four-fifty-five, Galactic time, whatever part of the day it was on the planet's surface. He had been in charge of the galaxy an hour, and it was time to issue his first directive.

"Marshal Mulok!" he called.

His voice must have been harsh, for they all stared at him with something akin to apprehension.

Crayn thought of the weary years of clawing his way upward in the Service. The galaxy was his life. Authority had become his cloak. Something deep inside him writhed in agony.

"Marshal," he repeated with dry lips, "you will send an urgent summons to Advisory Alternate Gax Ludauk. Inform him that he is in charge of the galaxy as of his arrival in this chamber!"

The messenger of the Galactic Staff found Kelvin Crayn standing on the ringwall of a Lunar crater, admiring the glowing half-disk that was the planet of his origin. The messenger was a young man, but he wore the insignia of a general and his scarred faced and piercing eyes told much of his space experience.

Nevertheless, although he had re-

heard his opening speech as he followed a servant out to where Crayn stood, he cast desperately about for something better to say when he was introduced. Finally, he nodded at the planet in the night sky.

"Very beautiful, sir, especially with its reflections on the clouds that way."

"Ah, yes," agreed Crayn. "Those are comparatively new, by the way. The magic of the galaxy that is available to a former Advisor had pretty well rejuvenated the old moon, but it was only recently that we could spare enough water vapor to put clouds in our new air."

"Remarkable, sir," said the young general. "Is that a city you are laying out on the floor of the crater?"

"Yes," said Crayn. "Some of that new grass will have to be sacrificed, I suppose, but we shall have a very neat town there presently. With a detachment of engineers from the Service, nothing at all seems impossible—except, of course, to ask for my old job back."

He examined the young general and nodded with approval.

"I think you may go far," he added, "so I'll give you a word of advice: If ever you resign a position, forget about it. One simply does not try to grab back the torch once it has passed on; but it is better not to think about it either."

"I'll remember, sir. In that connection, I have instructions to inform you of the staff's analysis of

the recent gains in Sector Eighty-four."

"Ah, yes," said Crayn with rising interest. "Gax Ludauk was quite successful, wasn't he?"

"The Advisor has secured a new and large group of stars in their alliance to the civilized galaxy," said the general. "After some months of analysis, the staff has determined the key decision that made it possible."

Crayn raised his eyebrows.

"You're not going to tell me—?"

"Yes, sir. You had formed a perfect estimate of the situation. Had any other high officer but the present Advisor been placed in charge, it is extremely likely that we should have suffered a serious reverse."

"Well . . . well!" murmured Crayn, after a delighted pause.

"I am to present your excellency with a scroll before the televisions tomorrow. It is the only small honor left to award you; for if you will permit me to say so, sir, a man in your position is above honors."

Crayn noted the admiring expression and smiled kindly. He beckoned to the servant, who stepped forward to guide the general back to the simple building atop the ringwall.

"Thank you, general," Crayn said. "I predict you will win medals for diplomacy, too. I shall look forward to your company at dinner."

When the young general glanced back over his shoulder, Crayn was gazing up into the sky, in the general direction of Beta Sagittarius. Perhaps he had unconsciously straight-

ened up, or perhaps it was an effect of the blue-green Earth light, but the officer carried away an impression of tremendous dignity.

After the footsteps had died away, Crayn drew a coin from the pocket of his tunic. He flipped it into the

clear, new air, caught it in his palm, and examined it resignedly. Then he scaled it out into the dusk over the crater.

"Heads again!" he muttered. "Whatever it was that I had, I seem to have used it all up!"

THE END

THE ANALYTICAL LABORATORY

We're really pressed for room this time, and have to get two Lab reports in—so here it is:

DECEMBER 1950 ISSUE

Place	Story	Author	Points
1.	Bindlestiff	James Blish	2.37
2.	Hand Of Zei (Pt. 3)	L. Sprague de Camp	2.50
3.	A Subway Named Mobius	A. J. Deutsch	3.00
4.	Compromise	H. B. Fyfe	3.62
5.	The Curfew Tolls	J. T. M'Intosh	4.14

JANUARY 1951 ISSUE

Place	Story	Author	Points
1.	Situation Thirty	Frank M. Robinson	2.20
2.	Berom	John Berryman	2.53
3.	The Waiting Game	Randall Garrett	2.60
4.	The Hand Of Zei (Pt. 4)	L. Sprague de Camp	3.50
5.	Cygnian Harvest	J. W. Groves	3.66

Incidentally, quite as usual—no story failed to get a vote for first place—and no yarn failed to collect a booby-prize vote! You know, even with telepathy an author or editor can't hit 100%!

THE EDITOR.

KEY DECISION

ASTOUNDING SCIENCE-FICTION

CLIPPER SHIPS OF SPACE

BY RUSSELL SAUNDERS

A fascinating suggestion for sailing ships of space, a seemingly wild notion, but actually worked out mathematically, it makes sense! It would be possible to sail on "the wind that blows between the worlds"! See Willy Ley's letter in Brass Tacks.

Illustrated by Orban

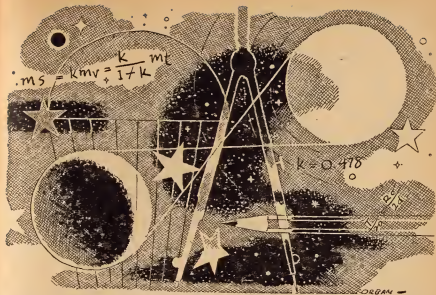
It is becoming more and more taken for granted that the only possible method of propulsion in a vacuum is the rocket. It is true that science fiction is full of various types of space-warp drives. However, even the fertile imaginations of writers in this field have not challenged the rocket as the only practical, or even possible interplanetary drive in the foreseeable future.

I intend to propose another method of propulsion in a vacuum which is based on present day physics. I will show that in many ways this drive is more practical than the rocket. In order to prove my point I will have to use a certain amount of mathematics. This will permit those who wish to, a chance to check my assertions. The rest may follow my verbal argument which I hope will be fairly coherent without the mathematics.

The proposed drive is based on a fact already widely known, the fact that light exerts pressure on material bodies. This pressure is very small except in the interiors of stars where its outward thrust prevents the stellar structure from collapsing under the pull of its own gravitational field.

Even in much less violent environments the mechanical forces exerted by light can become important if the areas of the material particles are large compared to their mass and other mechanical forces are very small. This is true of very small particles in outer space.

Whipple has pointed out that the radiation pressure by light from surrounding stars may be the agency which forms interstellar dust into sufficiently compact clouds to permit gravitational forces to take over and compress the cloud into a new star.



Long ago Arrhenius suggested that life would have voyaged through the intersellar void in the form of spores driven by radiation pressure. This idea was used in a fine science fiction story by Raymond Gallun, called "Seeds of the Dusk."

These considerations suggest the possibility of using a "sail" to obtain mechanical forces from the sun's radiation of great enough magnitude to drive a spaceship between the planets. It will be found as we proceed that the unique conditions that exist in the space between the planets actually make a drive of this sort feasible.

Except in regions very close to the planets, the gravitational forces are very small permitting the force of the sun's radiation on the sail to become a first-order effect. The sail

itself must be made of lithium or some other light metal, and must be very thin. Such a sail can only exist in a vacuum since it would react with the atmosphere. In addition, it would be so fragile it would be torn apart except in free space.

In order to test the feasibility of this idea we must decide what acceleration of the ship the sail must produce. Since the acceleration is applied continuously, the amount required will be minute compared to rocket accelerations. It is important to note that both the gravitational attraction of the sun and the radiation pressure on the sail decreases inversely as the ship's distance from the sun. This means that, when the sail is erected, the ship will behave as if the mass of the sun has been suddenly reduced. If the sail pro-

duces a force equal to the attraction of the sun at any distance from the sun, the two forces will balance at any other distance and the ship will travel in a straight line through the solar system. In practice, a force sufficient to allow the ship to travel along a hyperbolic orbit is believed to be sufficient. Such an orbit will permit our ship to travel anywhere in the solar system or even leave it if desired.

We may find the acceleration on the ship which the sail must produce to establish a hyperbolic orbit by remembering that a body in a stable circular orbit must double its kinetic energy, if it is to go into a hyperbolic orbit and escape the attracting center. Suddenly halving the mass of the attracting center would have the same effect. The repulsive force on the sail will halve the apparent mass of the sun, if it produces an acceleration outward which is half the gravitational acceleration of the sun at the same distance.

The gravitational acceleration of the sun in the orbit of Earth is -0.529 cm/sec^2 . Therefore, the sail must produce an outward acceleration of half this amount or -0.265 cm/sec^2 .

We must now find the total force acting on the ship and sail in order to find the acceleration produced by a given ship and sail design. This force will be the difference between the gravitational and radiation forces being exerted.

Let

$$m_v = \text{mass of the vessel}$$

$$m_s = \text{mass of the sail} = km_v = \frac{k}{1+k} m_t$$

$$m_t = \text{total mass} = m_s + m_v$$

$$P = \text{area density of sail in grams/cm}^2$$

$$\sigma = \text{radiation pressure on sail in dynes/cm}^2$$

$$A = \text{area of sail in cm}^2 = \frac{m_s}{P}$$

$$\alpha_s = \text{gravitational acceleration of the sun}$$

$$\alpha = \text{acceleration of ship}$$

$$F = \text{total force exerted on the ship}$$

When we consider the problem of attaching the ship to the sail we will see that the sail must be a hemisphere. The effective area over which the radiation pressure is exerted is the projection of the sail on a plane normal to the sun's rays. This projected area is the base of the hemisphere, which has half the area of the hemispherical sail.

The total force exerted on the ship is given by

$$F = \left(\sigma \frac{A}{2} + \alpha_s m_t \right)$$

$$= m_t \left(\frac{\sigma}{2P} \frac{k}{1+k} + \alpha_s \right)$$

$$\frac{F}{m_t} = \alpha = \frac{\sigma}{2P} \frac{k}{1+k} + \alpha_s$$

Now α must be half of α_s in order to establish a hyperbolic orbit. Putting in this value of α we may solve for k , the ratio between the mass of the vessel and the mass of the sail.

$$k = \frac{-\alpha_s}{\frac{\sigma}{P} + \alpha_s}$$

We will find k assuming the ship is in Earth's orbit. This value of k will give a hyperbolic orbit starting at any point in the solar system as explained before. We will choose magnesium for our sail material since it has a fair strength mass ratio and is opaque for sheets 0.15 microns thick which is the thickness we will assume. This makes P equal to $26 \times 10^{-6} \text{ grams/cm}^2$.

We will use the pressure exerted by the radiation of the sun at the surface of Earth on a surface reflecting ninety-four percent of the incident energy. This is $85 \times 10^{-8} \text{ dynes/cm}^2$. This figure is pessimistic since Earth's atmosphere scatters about thirty percent of the sun's radiation back into space. The ratio k is now found to be equal to 0.193. If we had desired to travel in straight lines, we would have found $k = 0.478$.

We have proved that the sun's radiation can produce adequate ship accelerations for sails which have between nineteen percent and forty-eight percent of the mass of the vessel. This shows that radiation pressure may be used as a practical drive for interplanetary ships.

The mass of the sail compares very favorably with mass of the fuel which must be carried by a rocket. The rocket requires fuel masses of over three times the mass of the

rocket structure while the sail of our "light-jammer" is less than half the mass of the ship. Furthermore, the rocket is good for one trip, then its fuel is exhausted and more must be ferried up from the surface of a planet. The sailing ship can operate for an indefinite number of voyages once it is constructed. An error in navigation may be corrected by maneuvering under sail. The rocket is helpless once its fuel is expended.

A hidden bonus is provided by the fact that the accelerations experienced by the ship are always minute. This means that the ship structure need only withstand internal air pressure. It may be a thin metal skin inflated to spherical form by the air within. This results in a ship which is mostly payload and very little structure. A rocket must be stressed to withstand the high accelerations which occur during operation of the motors. This results in a heavy structure and small payload.

Before going further we must examine the problem of attaching the ship to the sail. As mentioned before, the sail will be a hemisphere open toward the sun. The rim of the sail will contain a stress distributing wire and a series of rigging wires will go from the rim back to the ship. The sail will then look like a parachute with the ship suspended from it. Since the sail can withstand no shearing stress it will find a shape for which it is in pure tension. This shape will be close to hemispherical.

We must now make sure that the tension on the sail can be safely with-

stood by the metal. The radiation force on the sail is $\pi R^2 \sigma$ where R is the radius of the hemisphere. This force must be transmitted to the wire rim through the sail area immediately adjacent to the rim. The area of the metal through which the stress is transmitted is $2\pi R d$ where d is the sail thickness. The stress on the metal is then

$$\frac{R \sigma}{2 d}$$

Allowing a twenty-to-one safety factor, we will equate this stress to one twentieth the tensile strength of the metal. Or

$$\frac{T}{20} = \frac{R \sigma}{2 d}$$

where T is the tensile strength of the metal in dynes/cm². We may now solve for R to find the largest sail radius which will not overstress the sail.

$$R = \frac{T d}{10 \sigma}$$

If the ship is to approach the orbit of Mercury, σ the radiation pressure may be ten times its value in the Earth's orbit or 8.50×10^{-4} dynes/cm². The thickness d was taken as 1.5×10^{-5} cm in computing the value of k. T for magnesium is about 2.3×10^6 g/cm². Then R will equal forty kilometers. This is surely as large a sail as we would care to build for a long time to come.

We can now examine the design of a particular ship in order to make the design more concrete. Let the total mass be 100,000 kilograms or

a little over 100 tons. Then the sail's mass is 16,100 Kg and the vessel's mass is 83,900 Kg. The sail's area is 61 square kilometers and its radius is 4.4 kilometers. This radius is well within the maximum permissible radius of 40 kilometers. The force transmitted to the ship through the rigging will be the mass of the ship times the acceleration due to the sail or 2.26×10^4 grams. If the ship is three times the sail diameter behind the sail and the rigging is also magnesium, then it will have a mass of 1,960 kilograms, if a two-to-one safety factor is assumed. This figure includes the wire in the sail rim which is assumed to be the same strength as all the rigging wires.

Having satisfied ourselves as to the basic feasibility of the system we can now examine the method of operating our ship. The objection will be made that such a ship could never land on a planet. This is true but not a fatal objection. The ship must be docked at an artificial satellite circling the planet and passengers and freight ferried to and from the planet by rocket.

The ship itself must be built at the artificial satellite. The sail can be constructed by vacuum evaporation methods. A thin plastic sheet may be electrically charged. This will cause it to become rigid. Then lithium can be sprayed onto the sheet by heating the metal in a boiler and directing the resulting metal vapor at the plastic sheet with a nozzle. When the metal sheet is

completed, the plastic may be coated with lampblack so it will absorb heat and then turned toward the sun. The plastic will melt and may be stripped off by charging the boiler with respect to the sail. The resulting electrostatic attraction will cause the plastic to return to the boiler. It may then be formed into a new sheet.

The metal skin, which will become the ship, can also be constructed at the satellite and then inflated.

Let's now consider the problems of navigating the vessel. Many of its characteristics are similar to a normal sailing ship. Like its Earth-bound cousin, it carries no fuel and an error in navigation does not leave it stranded in space like a rocket would be in similar circumstances. Once constructed, our ship is good for an indefinite number of trips. This makes it appear that interplanetary travel could be accomplished on an economical basis. Most of the cost would be involved in the ferrying trips to and from the artificial satellites which act as docks for our deep-space vessel.

It has not been shown how our ship can go inward toward the sun, but this will be discussed very shortly. The fact that it is possible means that after the first sailing ships have been constructed of materials ferried up from Earth, all future ships should be constructed from material available in the asteroid belt. No fuel is required to get this



material into free space and once a ship is constructed it can be sailed anywhere throughout the system. Iron and nickel are available in the asteroid belt and the existence of stonelike meteors indicates that the same asteroids will contain light metal oxides. These oxides may be reduced to obtain light metals for sails and oxygen.

The book "The Atmospheres of the Earth and the Planets," edited by Dr. Kuiper, contains data which supports the belief that the inner moons of Saturn are composed of ice. These moons could be mined to furnish water, hydrogen, and oxygen. This material can be carried to free space without undue expenditure of energy since these satellites are small. The presence of methane and ammonia in the atmosphere of Titan furnishes a source for these gases for further synthesis and provides the elements nitrogen and carbon. Thus, the basic elements for construction and the support of life are probably available without the expenditure of large amounts of chemical energy needed to carry them into free space from the surfaces of the planets. Their location in the solar system does not matter since sailing ships can carry the material to the orbit desired without expenditure of chemical energy.

Returning to the navigation problem, we find that our ship must be sailed in the true sense of the word. Like an ocean-going sailing ship, we need a keel otherwise we can only "run before the wind." Fortunately,

the equivalent is available. It is the gravitational field of the sun or any of the planets. To make this statement more concrete, let us consider the problem of locating a stable orbit about a planet. The accelerations provided by the sail are not great enough to blow the ship out of the potential well surrounding the planet which is of great depth and very steep. However, the ship can escape by what amounts to tacking.

After erecting the sail, the ship must turn itself so that the sail is edge on to the sun while in the portion of its orbit during which it is approaching the sun and then turn the sail normal to the sun's rays while receding from the sun. The system will gain energy during each revolution and eventually will accumulate sufficient kinetic energy to leave the potential well.

If the ship and sail rotate about their common center of gravity at half the rate at which they revolve about Earth, then the sail will be edge on to the sun on one side of its orbit and normal to the sun on the other side. The fact that the ship is first on the sunward side and then away from the sun on alternate revolutions makes no difference since centrifugal force will keep the rigging and sail in tension in both positions.

As the ship spirals outward it will revolve more and more slowly. The rate of rotation may be decreased to keep step with this change by gradually lengthening the rigging wires. The time required to

escape from Earth's field is in the order of several months.

Since the forces acting on the sail are so minute, the orbit of the artificial satellite from which the ship starts its journey must be at a great enough altitude to reduce drag due to the residual atmosphere of Earth to a value low compared to the radiation forces on the sail. Using present estimates for the density of the upper atmosphere, the minimum orbit is found to be at an altitude of two thousand kilometers. By the time the ship reaches interplanetary space the drag due to gas will drop to about 10^{-5} the radiation forces.

Once the ship has escaped from Earth's field it can be maneuvered to any point in the solar system by opening and closing the sail at the proper times thus changing from one conic section to another. It is to be noted that on elliptical orbits where the ship is approaching the sun, the sail is actually doing work on the sun's radiation and the ship is losing energy.

However, in order to arrive at any given planetary destination with the same velocity as the planet, the ship must be able to change its angular momentum. This it cannot do as long as it experiences only central forces. Fortunately, the sail can produce a component of force normal to the direction of arrival of the sun's radiation. This may be done by turning the sail so that it does not make a right angle with

the incident energy. The reflected light will then leave the sail at an angle with respect to the radial line from the sun to the ship and a portion of the recoil will be a tangential force on the sail. If the sail were flat plate, the maximum tangential force is obtained when the sail is turned thirty degrees to the normal. The tangential force for this position is three fourths the force the radiation exerts on the sail in its normal position. Calculations show that if the ship possesses the same angular momentum per unit mass as Earth then by "tacking" with the sail cocked, the angular momentum of the ship may be adjusted to the correct value for making a landing on any of the inner planets in about a month.

The other method of changing the angular momentum of the ship is to guide the ship to an intermediate planet and make a hyperbolic passage near the planet. If this is done correctly, the ship can transfer the correct amount of angular momentum to the planet to make its angular momentum equal to the value required if it is to reach its destination planet at zero velocity with respect to the planet.

Since the ship can continually alter its course by sail trimming as it nears the intermediate planet, it is felt that the approach may be controlled accurately enough to make possible a precise control over the change in angular momentum caused by the passage by the intermediate planet.

THE END

THE ARGONNE HEAVY WATER REACTOR

The following material is a news release of the Atomic Energy Commission printed in its entirety, giving the history and the nature of the mechanism of the heavy-water nuclear reactor of the Argonne National Laboratories. Prepared under the direction of the technical personnel of the laboratory, it is as accurate and complete as security permits.

History: Because there was always the remote chance that graphite moderated nuclear reactors could not produce the fissionable material required for the program of the Manhattan Project, much thought was given in 1943 to the construction of a heavy water moderated reactor. In consequence, the production of heavy water in sizable quantities was undertaken—at other locations—early in the development of the atomic energy program. Measurements performed with the use of the graphite moderated pile during the summer of 1943 proved the feasibility of a heavy water reactor and had produced sufficient information to permit its construction.

Construction of a building was begun in September, 1943 and on May 15, 1944 the heavy water reactor was operated at low power.

Thus, it became the world's first heavy water nuclear pile.

Description: In comparison to graphite moderated reactors, the heavy water reactor is quite small. It consists of an aluminum tank, six feet in diameter and eight feet ten inches high, which is filled with approximately six and a half tons of heavy water—amount contained in thirty-two thousand tons of ordinary water—and into which are suspended one hundred twenty uranium metal rods which are one point one inches in diameter and six feet long. The uranium rods, whose total weight is nearly three tons, are arranged to form a square lattice with the distance from center to center being five and three eighths inches. The heavy water, which is present in ordinary water as one part in five thousand, serves to slow down the

speed of the neutrons in the same manner and for the same reason as is accomplished by graphite in the other reactor. Heavy water is more effective than graphite in slowing down neutrons and does not absorb neutrons as readily as does graphite. To remove the heat created in the fission process, the heavy water is circulated through a heat exchanger. Thus, the heavy water serves not only as a moderator, but as a cooling agent as well.

The reactor tank rests on a two-foot thick layer of graphite blocks supported by the concrete pile foundation. The graphite reflects the neutrons to the reactor core. In addition to this neutron reflector on the bottom, the sides are provided with a reflector of equal thickness.

A four-inch shield of lead-cadmium alloy surrounds the reflector and fits snugly against a thick concrete shield which encases the entire reactor. The lead-cadmium alloy protects the concrete from exposure to neutron and gamma radiation. A one-foot thick shield of lead bricks is placed on top of the graphite reflector and is continued over the top plate of the reactor tank. Between the bottom of the lead cover and the top plate of the reactor tank is a thin layer of cadmium metal. Neutrons escaping from the uranium section of the reactor are slowed down by collisions with atoms of heavy water and are then absorbed by the cadmium shield. This absorption of neutrons causes the cadmium to become radioactive and to

prevent the passage of gamma rays from the cadmium it was necessary to provide the lead shield. (The capture of a neutron by any material immediately results in the formation and emission of a gamma ray). The lead serves as a shield against gamma rays, thereby protecting personnel during the loading and unloading of fuel. The thick lead shield at the side and bottom carries a system of copper tubing for circulating cooling water to remove the heat generated in the shield and in the graphite.

The space between the heavy water and the cover of the tank is filled with helium. This inert gas replaces ordinary air which would normally be present and which must be kept out of the system. Moisture, in the air, would be condensed inside the reactor tank and would dilute the rare and expensive heavy water. Another objection exists with reference to the use of air. Inasmuch as nitrogen constitutes, by volume, about four-fifths of the atmosphere, the presence of air would, under bombardment by radiation, result in the formation of nitric acid.

The reactor's helium is circulated through a cooler and through a catalyst chamber by two blower pumps. These pumps, one of which is normally a stand-by pump, circulate the helium gas and dissociated heavy water. Heavy water molecules, under the bombardment of neutrons, break apart to form oxygen and deuterium—a rare form of hydrogen

which has a weight double that of ordinary hydrogen—and these gases become mixed with the helium gas in the reactor tank. The deuterium and oxygen are recombined in the catalytic chamber and the re-formed heavy water is withdrawn and returned to the reactor tank.

Concrete Biological Shield: The reactor core is surrounded with a biological shield which is in the form of an approximately octagonal concrete cylinder thirteen feet high. The concrete shield is eight feet in thickness. The top of the reactor is shielded with a four-foot thick layer of blocks of wood and steel which weigh eighty tons. Only five of the eight faces of the reactor are visible because the cooling machinery room encloses within itself three of the faces.

Experimental Openings: Eleven openings, closed by removable shielding plugs, penetrate the biological shield and the graphite reflector to provide facilities for measuring the neutron intensity of the reactor, for exposing materials to neutrons, and for permitting the passage of beams of radiation from the reactor. Four of these openings contain ion chambers—neutron detection instruments—which are used in operating the reactor. The other openings may be opened up to permit the passage of beams of neutrons or may be used for the introduction of materials into the reflector near the reactor tank for the purpose of making them radioactive by exposure to neutrons.

On the east face of the reactor is a large opening—roughly thirty inches square—which is used for radiating materials by neutron exposure. The opening is filled with twenty hollow graphite straggers into which may be placed the materials to be irradiated.

Neutron Column: A thermal neutron column serves to permit the passage from the reactor of a beam of slow neutrons. The column consists of a stack of ordinary graphite blocks five feet square and seven feet-eight inches long which extend back to the neutron reflector. The end extending through the concrete shield is covered with a cadmium curtain and a two-foot thick lead and iron shield in which an eight-inch square opening is provided. Neutrons created by the reactor are slowed down, to be in equilibrium with the thermal agitation of the graphite molecules, by numerous collisions with graphite atoms and, when needed in research experiments, may be permitted to leave the reactor through this opening. The size of the opening may be altered by changing the size of the cadmium cover.

Robot: In many experiments, the materials made radioactive in the reactor must be removed from the reactor in a short time. To make possible the quick introduction into and removal from the reactor, of materials which lose their radioactivity after a few seconds, a pneumatic tube arrangement has been built into one of the eleven openings

which pass through the concrete shield. Materials to be irradiated with neutrons are placed in small plastic cylinders and are "shot" in and out of the reactor in much the same manner as department stores speed money from one section of the store to another. Helium gas, which does not absorb neutrons and becomes radioactive, furnishes the push which speeds the samples in and out of the reactor.

Central Experimental Tumbler.

In addition to the eleven openings in the sides of the reactor which have been described above, an opening known as the central experimental tumbler extends from the top of the reactor into the heavy water. This opening has been made by extending a four-inch aluminum pipe from the center of the top shield, through the tank lid, and down to within a foot of the aluminum tubes through which various samples may be lowered into the center of the reactor for exposure to fast and slow neutrons. Thirty-two irradiations may be performed simultaneously by the use of this facility.

Control Systems: The Argonne heavy water reactor is equipped with two control rods, two safety rods, and three shim rods. All contain cadmium metal so that they will absorb neutrons and stop the chain reaction.

The safety and control rods are each formed of a three and one half inch tubular sandwich of 1/32 inch cadmium placed between two alumi-

nium tubes. These rods are hinged to the bottom side of the cover of the heavy water tank. When they are in the "in" position—reactor would not be operating—they are hanging about thirty degrees from a vertical position. When the rods are in the "out" position, they are suspended in an almost horizontal position above the water in the tank. These rods move through a sixty-degree arc.

The shim rods, sometimes called auxiliary control rods, are contained in aluminum tubes and are mounted inside the tank in a vertical position with one end of the rods penetrating through the top of the reactor tank.

Cooling System: The heavy water is pumped from the top of the reactor, passed through a heat exchanger located in the adjacent pump room, and fed back into the reactor tank through an opening at the bottom of the tank. In this way, three hundred kilowatts of heat is removed from the reactor. The heavy water flow rate is two hundred gallons per minute. Experiments have shown that this rate of flow produces only a minor ripple in the surface of the water and experience has shown that this ripple does not introduce any instability into the reactor.

In normal operation, the average temperature of the heavy water flowing from the tank to the heat exchanger is ninety-five degrees Fahrenheit while the heavy water being re-introduced into the reactor is, on the average, about seven or eight degrees cooler.

The heat exchanger permits the heat to flow from the heavy water to the cooling water, but does not permit the flow of heavy water into the light water. There is a certain amount of radioactivity associated with the heavy water, but there is no way for this activity to be transmitted to the cooling water. Should a leak occur, radioactive heavy water might enter the light water cooling system, but Geiger counters inserted in the cooling line would immediately reveal the presence of radioactivity and necessary steps to prevent further loss of the valuable heavy water would be taken.

Operation of the Reactor: The controls for operating the reactor are located in a room near the reactor's north face. Here, an operator may measure and control all of the major aspects of the reactor's operation. To start the reactor, the operator merely pushes a button and the thirty-two pound safety rods are pulled out of the reactor. By pressing another push button, one of the two motor-driven control rods is removed. To shut off the reactor, the operator causes the safety rods to fall back into vertical positions inside the tank. If the power of the

reactor should become too great, if some of the controls should fail to function, or if there should be an interruption in the electrical power supply, the safety rods would automatically fall into the "in" position by gravity and the reactor would shut-down immediately. As a further measure to cause a sudden stop in the operation of the reactor, a properly located large quick-opening valve can discharge the moderator by gravity to a storage tank.

The shim rods are usually not moved but are allowed to remain fairly constant in day to day operation. Occasionally, however, they are adjusted when materials are irradiated in the reactor. For example, if a material possessing great ability to capture neutrons is placed into the reactor for irradiation, the shim rods will be withdrawn to reduce the amount of neutron capture by the cadmium in the shim rods, thus making more neutrons available for capture by the newly-introduced sample. Conversely, in some instances, the rods would be lowered deeper into the water so as to increase the number of neutrons being captured.

THE END

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ASTOUNDING SCIENCE-FICTION

BOOK REVIEWS

"The Castle Of Iron," by Fletcher Pratt and L. Sprague de Camp. Gnome Press, New York. 1950. 224 pp. \$2.50

The Harold Shea stories in *Unknown* were probably as representative of the wholly wacky logic of that unique magazine as anything it ever published. The first of the series, combined in "The Incomplete Enchanter," have just been reissued by Prime Press in a new edition with a catchy Tschirky jacket. Now Gnome is adding an embellished version of the final adventures of Shea, Chalmers, Vaclav Polachek, Belphebe, and assorted allies and hostile warlocks in the world of Ariosto's "Orlando Furioso"—a realm of Saracen sorcerers, Frankish-unheroic—heroes, an inept werewolf, a complacent hippogriff, and a couple of inadvertent *djann*. Pratt and de Camp learnedly but irreverently wreak the same havoc with Ariosto that they did with Spenser's "Faerie Queene" and the Norse eddas. If it hasn't quite the adroit-

ness of incongruity which marked the first book, there is certainly nothing like it in print, and not likely to be. You will have to have it.

P. Schuyler Miller.

"The Bridge Of Light," by A. Hyatt Verrill. Fantasy Press, Reading, Pa. 1950. 248 pp. \$3.00

One of the most versatile writers ever to turn his hand to science fiction has been A. Hyatt Verrill, naturalist, explorer, archeologist, and author of one hundred and ten books of which "The Bridge Of Light" is his first adult science fiction novel.

This is an adventure yarn of the H. Rider Haggard lost-race school which draws on the author's own intimate personal knowledge of the Indians of Central America and of the great Maya civilization for its plot and color. The narrator, finding a lost Maya codex or book of picture-writing in Spain, learns that it is the Prophecy of Kukulcan, the

BOOK REVIEWS

white god of the Mayas, and that it gives directions for finding the lost city of Mictolan where the remnants of the Mayan aristocracy have been awaiting Kukulcan's return to lead them back to greatness. He follows the directions of the codex to Mictolan and is at once accepted as the son of Kukulcan, plunging into the usual intrigue to overthrow an evil priest and restore a noble ruler to the throne, incidentally winning a beautiful maiden. The monsters of the Mayan mythology appear as relict dinosaurs, and there are added mysteries of physics—a radioactive clay which dissolves stone, and the "Bridge of Light" itself—to account for some of the seeming impossibilities of Mayan culture.

The author's picture of the strange magnificence and incongruities of Mayan culture adds a feeling of authenticity to a rather routine plot, and Edd Cartier has done one of his best jackets for the book.

P. Schuyler Miller.

"The Big Book Of Science Fiction," edited by Groff Conklin. Crown Publishers, New York. 1950. 545 pp. \$3.00

Although with fewer pages, Groff Conklin's latest anthology is a good inch thicker than August Derleth's time-spanning panorama, "Beyond Time and Space," and can, therefore, justify its title. Its thirty-two stories span the period from 1889—a

little known Jules Verne prophecy "In the Year 2889"—down to the present. About a third of the stories come from this magazine, but most of the currently active members of "the competition" are also represented as are the *Saturday Evening Post* and *All Story* of 1918. The stories are grouped under six heads: "Inventions, Dangerous and Otherwise"; "Wonders of Earth and of Man"; "From Outer Space"; "Adventures in Dimension"; "Far Traveling"; and "World of Tomorrow." As in the other Conklin collections, there is a wide representation of authors, but alas no Heinlein! The make-up is unfortunately rather crowded in order to hold the price to two-thirds that of the Derleth survey. A must, of course. Soon you'll be able to throw away your magazine files and rely on the anthologies for whatever is worth keeping.

P. Schuyler Miller.

"Ralph 124C 41+," by Hugo Gernsback. Frederick Fell, Inc., New York. 1950. 207 pp. \$2.50

The forewords by Lee de Forest and especially by Fletcher Pratt point up the chief interest of this "classic" of 1911. Few science fiction novels have ever scored so fantastic a success in their predictions of inventions and discoveries to come. If the timing is off—Ralph is supposed to live in 2660—it is be-

ASTOUNDING SCIENCE-FICTION

cause Hugo Gernsback wrote impatiently in a leisurely age, before science and engineering took the reins and whipped up the horses of progress. We can blush at the fact that the basic space-opera plot of forty years ago has changed so little, but some of the variations played on the old theme—in particular Ralph's pursuit of the Martin villain, disguised as a comet—are good fun. A collectors' item.

P. Schuyler Miller.

"The Man Who Lived Backward," by Malcolm Ross. Farrar, Straus & Co., New York. 1950. 461 pp. \$3.50

Without hampering himself with the inner consistency which would be required of a main-stream science fiction author, writing for this or one of the other principal magazines in the field, Malcolm Ross has dealt interestingly, humanly, and at too great length with the paradoxes involved in being born in 1940 and dying in 1865. His hero, Mark Selby, is born under circumstances which are never entirely unraveled and dies trying to interfere with history by preventing Lincoln's assassination. He has meanwhile tried to change that flow in the Homestead strike, equally without success, and has meddled with the so-called Christian commune in Georgia and been found out by a dying Walt Whitman.

Purists may boggle at Selby's

means of progress backward through our time; he seems to snap back some time during sleep to the morning of the previous day, then live through it normally as we do from waking to sleeping. There are other inconsistencies, but the book is oddly consistent in its picture of the time-twisted Selby, trying to fit himself into a world which for him runs backward.

P. Schuyler Miller.

"Genus Homo," by L. Sprague de Camp and P. Schuyler Miller. Fantasy Press, Reading, Pa. 1950. 225 pp. \$3.00

What the world might be like a million years or so from now is the theme of this delightful volume, and not even the wildest imaginings of the most ardent science-fiction fans can come near the story that De Camp and Miller have dreamed up. They must have had a good time writing it; that fact is apparent all through the well-written, literate job they have made of it for the mature reader. It is, as far as I know, unlike anything else that has appeared recently in the field. The authors here deal with characters that are three-dimensional, that are not merely the stock figures that move through too many science-fiction books but are definite personalities, who are believable and who react in a credible way to incredible circumstances.

Picture a civilization in which most metals have disappeared, a time in which rats weigh two or three hundred pounds, and hares are as big as mules. Take a busload of all kinds of people lost in a literally howling wilderness, people who are the last surviving members of their and our own race. Imagine simians who have evolved into the dominant entities on earth—with the beavers running them a close second. Mix these ingredients together with humor, sound science, and certainly sly digs at the history and events of our own time, and you will have a faint idea of what this book has in store for you. You will find no interplanetary travel, no visitors from outer space, not even one exotic drug nor any ways of harnessing solar energy to drive spaceships. You will, however, find some of the rarest episodes ever penned. De Camp and Miller, who have made their reputations as master storytellers separately, now combine to prove that their whole is larger than the sum of their parts.

C. Coffin.

—
"The Voyage Of The Space Beagle,"
by A. E. van Vogt. Simon and
Schuster, New York. 1950. 240 pp.
\$2.50

"Black Destroyer" was and is one
of the finest science fiction stories of

the last fifteen years. It now serves as curtain-raiser for a series of episodes in which the crew of the *Space Beagle*, outward bound through the fringes of our own galaxy to the Andromeda universe, meet, are threatened by, and defeat the monstrous representatives of rival races. The second longest of these adventures appeared here as "Discord in Scarlet," and a short connecting link has been published elsewhere as "War of Nerves."

The complete rewriting of these stories to give them some of the unity needed in a novel has created the character of Elliott Grosvenor, Nexialist of the expedition, a diffident exponent of the new science of things as a whole. Nexialism in this book might be considered the parallel of the Null A philosophy in van Vogt's previous volume in this series, but it has not been so well developed, either through explanation or example, as was the world of A. Grosvenor is retiring to the point of being exasperating, and neither his own struggle for recognition nor the built-up feud between Morton and Kent for directorship of the expedition gives the book the unity a novel needs. The catlike Coeurl, the birdlike Riim, the red devil Ixtl, the gaseous, whispering Anabis of the final episode are interesting enough concepts, but this is one case where the whole is less than its original parts.

P. Schuyler Miller.



BRASS TACKS

Dear Mr. Saunders:

I herewith return the carbon copy of your piece which you sent me and which I have read carefully in the meantime. I did not have the time to check your calculations in detail, but they look all right and I am willing to accept your figures.

I think that the idea itself is fascinating and if you get it published somewhere somebody in the future may decide to try it. But I think that any try-out will be essentially in the nature of a sportive event. I cannot see any practical benefit, even disregarding the fact that the whole method could not be made to work until *after* rockets have opened up space and enabled us to build artificial satellites. I won't even go into

detail about the difficulties of building and handling a "sail" of an area of several square miles. The facts of nature which speak against the use of a "light jammer" except for sportive competitions, lie elsewhere.

Incidentally I believe that in your description on page 9 of your manuscript you overlooked one factor. You say there that the sail would be "Edge on." But since the sail is a hemisphere or a shape close to a hemisphere and since the geometrical projection is the effective area, such a sail "edge on" is only half as large as it is "full up." At any event it would be a commercially unfeasible maneuver to ease such a ship out of the gravitational field of a planet. You may not have to fuel

the ship, you do have to fuel the crew. And you'll have to pay them too, probably at a rate based on time. The light drive, therefore, would be practical only if the ship takes off from a satellite station which is a considerable distance from the planet, say at a distance of six radii. But what you then get is merely a power to move the ship from one planet to another, say from Earth to Venus or Earth to Mars or from Mars to the planetoid belt. You would again have to land on a satellite station quite far removed from its primary planet. In other words the sun will furnish power only for moving in its own gravitational "well." And that, once you have passed the orbit of Venus, is not very much any more. The big power consumption is always the take-off from the planet. Therefore, I almost feel that for the movement of, say, ten kilograms of matter from the surface of Earth to the surface of Mars the "light jammer" won't do any better than a ship that can make the trip directly from one "near" satellite station at one end to another "near" satellite station at the other end.

Since overcoming the sun's gravitational field is only such a small percentage of the total I'm afraid that the utilization of solar light pressure just wouldn't pay.—Willy Ley.

Willy's probably right — but the idea is intriguing! And maybe a not-too-heavy fueling mechanism could be worked out.

Dear Mr. Campbell:

In the November, 1950 issue of ASF appears a letter by one Theodore Vincent of Brooklyn. This letter is so filled with Aristotelian claptrap, stylized thinking, and numerous other shilly-shally that we feel compelled to answer it.

Mr. Vincent speaks with the voice of Authority of the agronomist, the agriculturist, the non-ecologist, et cetera, and we wonder what his discipline is. What are his references? For instance, he says, "... it takes about 2/5 of an acre of cultivated land to feed one person." Possibly, but when you also clothe 'em, clean 'em, house 'em, and give 'em gadgetry to play with, the figure rises to 2.8 acres per person—according to Vogt.

Mr. Vincent describes great waste areas on the Earth's surface and says, "Science already knows precisely how to conquer these spaces. . . ." Yeh? Whose science?

There's lots more, but we won't go into that now. What we would like to bring out is that Vincent either missed the point of Vogt's "Road To Survival" or he never read it. Let's accept, for the sake of argument, that Vincent's figures are correct. The result—that the Earth could sustain six and one half billion people—is precisely what the ecologist would expect from any given species of animal.

There's an old story, repeated over and over again these last five hundred fifty million years, that goes something like this: The domi-

nant life species will breed right up to and beyond the carrying capacity of the land. Then the species will file under 77-B, go bankrupt, *kaput*, and the next species takes over.

Sure, the North American continent could keep five hundred seventy-seven million people—in the style to which the Oriental is accustomed. The great bulk of us would scream under those conditions, and we dare say Mr. Vincent would, too.

The point, then, is this: If we control our breeding, we may be able to maintain our "standard of living." Real simple, but as far as our paleobiologists have been able to make out, we are the first species to recognize this and be in a position to do something about it.

We have the choice then—uncontrolled breeding and sure death, or a little common sense and at least a chance for survival and the landing on Procyon IV!—Les and E. Cole, 3040½ Adeline Street, Berkeley 3, California.

Eating steaks is not as efficient a feeding process as eating rice—but I like it better!

Dear John:

If it's not too late, there's a statement in my review of "Time, Knowledge and the Nebulae" which needs modification. Toward the end of the review I said that one implication of Milne's thinking about the red shift is that the universe is not expanding. This is a true state-

ment as far as tau time is concerned, but in t time the expansion is taking place just as in Lemaitre, and the universe can be traced back to a beginning in finite time.

The difficulty is that in Milne both concepts operate simultaneously, just as do the particular and probability-packet views of electrons; neither is any "truer" than the other. My own statement would be "truer," though, if we could follow it with a parenthesis: ". . . the universe is not expanding—speaking in terms of Milne's tau or atomic time-scale only."

If the review is already in type, perhaps the above note could go in Brass Tacks.

Your January editorial on tools contains, it seems to me, a point that ought to be underlined a few times. Someone is almost sure to point out that, despite the fact that the Germans began World War II with no, underline no, cyclotrons, the Germans nevertheless had a heavy-water pile all set to go in Berlin when the Allies entered that city; apparently the only thing that had them stopped was the shutting off, by direct military action, of their heavy water supply.

Nevertheless, the correlation between lack of tools and lack of men who understood the tools is real and had a decided, observable effect upon German nuclear research. They decided early in the game, for instance, that a nuclear bomb was not possible—that fission could be made useful only as a comparatively

low-energy affair, for supplying industrial power. The effect of this decision on the course of the war doesn't need much pointing up, I think.

But I think you still leave one question open, the real question mark for our future. Granted that superiority in such basic areas as computer techniques will make for faster advance in fundamental research in the United States than in any other country, with results showing up eventually in superior weapons. As things seem to stack up now, we've a lack of hands to put those weapons in; Korea has already shown us that an overwhelming superiority in equipment is not a one hundred per cent effective answer to an overwhelming superiority in manpower.

And since we seem already to have reached the stage where any greater "efficiency" on the part of our weapons will involve injury to ourselves and our friends as well as to the opposition, the prospect of still more "gains" being made in this field, whether we make them or the other guys do, is not one to make me feel any surge of confidence. There is a faint hope that the exponential curve of technical advance which we seem to be riding may take us the equivalent of a century ahead of any possible opposition in the next few years, enabling us to mount a quick and conclusive sort of war in comparative safety. If, however, as seems far more likely, our advantage is only a matter

of the equivalent of a decade or so, the whole planet is due to catch hell, with results which will probably make the gloomy predictions of post-Hiroshima science-fiction stories seem downright sunny.

In short, a widening superiority in techniques is no reassurance once a given threshold of destructiveness has been passed. Bored as people now profess themselves to be with any discussion of "atomic doom," I think we should continue to bear in mind the probability that our next major war is going to be our last one—and continue the attempt to impress that probability on our legislators.—James Blish.

What we need more than a hydrogen-super-bomb is an infantry weapon capable of laying down AND MAINTAINING a literally impenetrable wall of death, through which no living being can penetrate. More effective bombs destroy civilizations; more effective infantry weapons could destroy warfare.

Dear Mr. Campbell:

I've just finished reading the February issue—which contains an excellent R. F. Jones story. There, to my surprise, I noted what is probably the first mention of Gödel's remarkable incompleteness theorem to appear in a nontechnical publication. Actually Mr. Kinman's version is not quite correct, and since I have

just finished teaching a semester course, the highspot of which was the proof of just this result, I couldn't resist writing you.

The theorem in question proves the existence of undecidable propositions, not with respect to all of "pure mathematics," but rather with respect to certain particular systems of logic—with, however, a great deal of freedom as to the details of their construction—which attempt to formalize various branches of mathematics, in particular, the elementary theory of positive integers. It is proved that any such logic must contain some proposition which can be neither proved nor disproved within the logic. The method of proof of this strange result resembles the paradox of the

liar—as stated by Mr. Kinman—in that the proposition involved is so constructed that it asserts that it itself is unprovable ("unprovable"—not "false" and not "disprovable"!) in the logic. Now, a few moments reflection shows that such a proposition must be true—suppose it were false!—and therefore—by what it asserts about itself—unprovable. The correct picture seems to be that of an infinite chain of logics of increasing strength—each containing undecidable propositions, which, however, can be decided on the next level. A corollary—not an obvious one—of Gödel's theorem is that the consistency of any such logic cannot be demonstrated within the logic.

A related result—due to Professor Alonzo Church of Princeton



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Our hearts were filled with gratitude for our boys in uniform during the fighting.

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University—is to the effect that for no such logic can there be a purely mechanical procedure for determining whether or not a proposition is provable in the logic. This seems to answer in the negative the question: "Can creative mathematicians be entirely replaced by a mechanical computer?"—Martin Davis, Urbana, Illinois.

So the calculating machine can't replace Man, and . . . er—uh . . . where does that leave Man?

Dear Sir:

We've been slighted. Or maybe you don't consider Long Island a part of the United States. At any rate, I'd like to submit a bit of a qualification to some of your editorial statements* regarding the North Carolina State College non-secret nuclear reactor. Actually, everything you say is reasonably true and we wholeheartedly concur with your opinions as to the importance of this development.

However, there is a good sized "pile" almost in your back yard that is not run by AEC employees. You see, the Brookhaven National Laboratory is financed by the AEC, but administered by Associated Universities, Incorporated, a board representing nine important universities in the northeast. This technicality is important because we at the lab are not really AEC employees and are not required to work on govern-

ment required problems. One of the purposes of the lab is to provide a facility for the northeastern universities having features which an individual school could not afford. Also, the lab is devoted to fundamental, peace-time applications of nuclear energy. The problems to be investigated are dreamed up by the individual investigators.

The feature of complete nonrestriction for the North Carolina reactor is important. It is true that the Brookhaven reactor is accessible without restrictions only to individuals who have been completely "cleared"—a pre-Dianetics usage—by the FBI. However, one face of the reactor has been declassified and after a few changes to isolate this area have been made the reactor will be available for use by only partially FBI-cleared scientists from the participating universities. The type of research which you imply can be done only at North Carolina can also be done at Brookhaven. Fortunately, there's enough of it to be done that no competition is involved. The real significance of the North Carolina reactor, then, is not so much what kind of problems are to be investigated as it is the big step of completely removing security restrictions upon the individuals concerned.

It seems to us that while you were discussing such things the Brookhaven reactor could have been mentioned—if only for the record. Perhaps you can add a note. Or better yet, come out and see us some time.

The cosmotron, the three billion-electron-volt proton accelerator,* is fully as spectacular as the "pile" and isn't a bit classified.—James S. Robertson, M.D., Ph.D., Upton, New York.

Sorry, Brookhaven! That material wasn't sent to me.

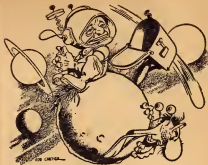
Dear Mr. Campbell:

With respect to L. Ron Hubbard's "To the Stars," suppose that a field-type drive is never found? Then the controversy between you and Milton Rothman in the December issue will be a very tiny "bug"—the question of the ratio of the initial to the terminal rest mass—in comparison to that deriving from the vaporization of the reaction plate and exhaust tubes of a rocket-type spaceship on interstellar voyage #1. It will take about three months at 1-gravity acceleration to get the ship up to ninety per cent of the speed of light, four to four and one third years—Earth time—to coast most of the way to the triple star, our closest neighbor, Alpha Centauri—of which system Proxima is member C—and three months to brake back down to a stop.

During the first three months of acceleration, with lithium-hydride pile popping off minute chunks of itself backward along the flight-line, the temperature of the reaction plate

*See the February Scientific American for a photo.

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will be around twenty-five million degrees. My handbook lists hafnium carbide as melting around 4160°C and nothing much higher. Those vaporized portions of the hafnium carbide reaction plate which fly straight back along the flight line at high velocity—equivalent to an individual temperature for each particle in the megadegree region—will represent a high-efficiency reaction. However, those portions will be in a minority—very much so—for they have to compete with (a) particles of low velocity going the same way back and representing a lower energy-per-pound-of-fuel efficiency—in fact TOO LOW—; (b) high velocity particles going in other and WRONG directions, such as into the tube walls and vaporizing them and into the ship forward and vaporizing it; and (c) low velocity particles going in these other directions, since these, too, will still be fast and hot enough to vaporize the ship or portion thereof. Suppose we cool the tubes and the reaction plate so successfully that only a shallow layer of the exposed surfaces are vaporized, and that we have some mechanical means for continually condensing these vapors, casting, heat-treating, and re-machining them into more tubes and reaction places in shops inside the ship? We can still never capture the low velocity particles going out of the ship—item (a) above—at low efficiency backward along the flight line . . . and the loss totos up about as follows:

OPTIMUM VESSEL SHAPE:

Disk, very great in diameter compared to thickness.

OPTIMUM ORIENTATION:

Axial flight in space.

PROPULSION: Nuclear explosions all over the reverse surface of the disk.

COOLING: Reaction plates of tantalum carbide liquid-cooled with gallium.

TUBES: None. Reactions open to the rear celestial hemisphere.

EFFICIENCY OF HIGHEST VELOCITY PARTICLES:

Fifty per cent of rest mass of fuel from which these photons form, if annihilation occurs; fifty per cent of binding energy of fuel from which these particles form, if fusion is used; fifty per cent of binding energy increment of helium ash, if fusion is used . . . each figure less a second order edge-loss decrement.

EFFICIENCY OF LOWEST VELOCITY PARTICLES: 0.

MEAN EFFICIENCY AVERAGE OVER VELOCITIES BETWEEN c and ZERO: Same as pile or reaction efficiency. This depends upon how much nonreactive matter is interlarded into the reactant for engineering reasons. And on how close the reactant molecules are to the nonreactants, and on the effective molecular cross sections of the nonreactant molecules and the reaction activated particles. With no nonreactive matter to the rear of or in between the reactant molecules, the nuclear

to the chemical densities—ratio is the sole factor affecting efficiency—a billion to one is a rough rule of thumb (ratio of White Dwarf matter density to Earth density let's say). With the reactant spread thin over the rear side of the disk, no critical mass effect is present to permit us to set up a chain reaction. Quite the reverse, the high velocity particles have almost no chance of striking each other, or any other matter to the rear or the side, so that the rearward energy flow, instead of being fifty per cent of theoretical is about the cube root of one billionth, or 0.1 per cent of theoretical.

RESULT: Our efficiency is 0.1 per cent of that specified by Mr. Rothman for a field-drive if we use a nuclear drive instead. Instead of carrying Mr. Rothman's one hundred pounds of fuel for one pound of payload—or nonpayload—we may carry one hundred thousand pounds.

CONCLUSION: We may get to the planets easily enough, but when we get the stars in our eyes again, we'll need that field-drive!
—Alan F. Wilson, 10217 St. Clair Avenue, Cleveland 8, Ohio.

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